October 1995

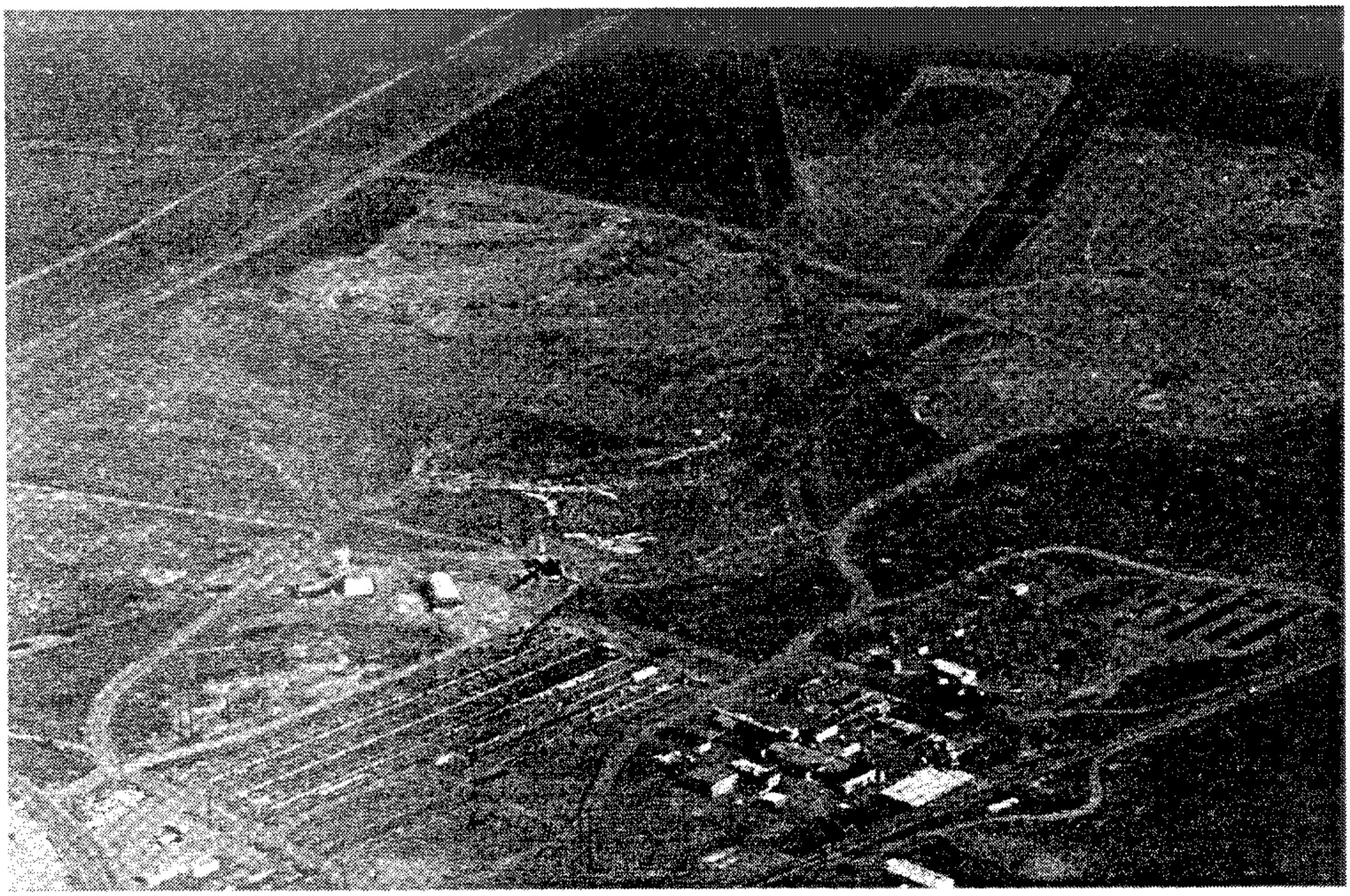
Idaho National Engineering Laboratory

IDAHO DEPARTMENT OF HEALTH AND WELFARE
DIVISION OF ENVIRONMENTAL QUALITY

Record of Decision

Declaration for Central Facilities Area Landfills I, II, and III (Operable Unit 4-12), and No Action Sites (Operable Unit 4-03)

Idaho National Engineering Laboratory
Idaho Falls, Idaho



Aerial view of Central Facilities Area Landfills I, II, and III

DECLARATION OF THE RECORD OF DECISION

SITE NAME AND LOCATION

Central Facilities Area Landfills I, II, and III
Idaho National Engineering Laboratory
Idaho Falls, Idaho

STATEMENT OF BASIS AND PURPOSE

This decision document presents the selected remedial action for the Central Facilities Area (CFA) Landfills I, II, and III located at the Idaho National Engineering Laboratory (INEL). The remedial action was chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA), and is consistent, to the extent practicable, with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, 40 CFR Part 300). Information supporting the selection of the remedy is contained in the Administrative Record for the CFA Landfills.

The lead agency of this decision is the U.S. Department of Energy (DOE). The U.S. Environmental Protection Agency (EPA) approves of this decision and, along with the Idaho Department of Health and Welfare (IDHW), has participated in the evaluation of final action alternatives. The IDHW concurs with the selection of the preferred remedy for the CFA landfills.

This decision document also summarizes information on 19 Track 1 investigations (consisting of underground storage tank sites) designated as "no further action" and documents the "no further action" decision for these sites.

ASSESSMENT OF THE SITE

Uncertainty associated with hazardous substances potentially disposed in CFA Landfills I, II, and III may present a potential threat to public health, welfare, or the environment if not addressed by implementing the response action selected in this record of decision (ROD).

Due to the uncertainty associated with the landfill contents and the need for containment of the landfill contents, a remedial action of containment is warranted for the site, even though the risk assessment indicates that the CFA landfills do not currently present an unacceptable risk to human health or the environment. Implementation of the remedial action selected in this ROD will provide for containment of the waste with a native soil cover, institutional controls, and monitoring.

DESCRIPTION OF THE SELECTED REMEDY

The selected remedy addresses the source of contamination by containing the buried wastes and contaminated soils. The selected remedy will minimize the CFA landfills as a source of potential groundwater contamination and reduce potential risks associated with exposure to the contaminated waste. The selected remedy includes elements that are consistent with EPA's *Presumptive Remedy for CERCLA Municipal Landfill Sites.*

The major components of the selected remedy include:

- Placement of a native soil cover (in combination with the existing soil cover) to a minimum depth of 2 ft, compacted and graded to minimize erosion and infiltration by controlling surface water runon/runoff, resulting from seasonal precipitation.

- Implementation of administrative controls on future land use and the posting of signs.

- Conducting groundwater, infiltration, and/or vadose zone monitoring to monitor the effectiveness of the remedial action. A monitoring plan will be developed by the agencies during the remedial design phase.

- Periodically inspecting and maintaining the cover to ensure its integrity.

- Maintaining institutional controls, including signs, postings, and land use restrictions.

STATUTORY DETERMINATION

The selected remedy is protective of human health and the environment, complies with Federal and state requirements that are legally applicable or relevant and appropriate to the remedial action, and is cost-effective. Because the wastes can be reliably controlled in place, treatment of the principal sources of the site was not found to be practicable. Therefore, this remedy does not satisfy the statutory preference for treatment as a principal element of the remedy. A remedy in which contaminants could be excavated and treated effectively is precluded because of the size of the landfills and because there are no known on-site hot spots that represent major sources of contamination.

Because this remedy will result in potentially hazardous substances remaining in the landfills on-site, a review will be conducted within 5 years after commencement of the remedial action, and every 5 years thereafter, to ensure that the remedy continues to provide adequate protection of human health and the environment.

Signature sheet for the foregoing Central Facilities Area Landfills I, II, and III at the Idaho National Engineering Laboratory Record of Decision between the U.S. Department of Energy and the U.S. Environmental Protection Agency, with concurrence by the Idaho Department of Health and Welfare.

9/25/95

John M. Wilcynski Date
Manager
U.S. Department of Energy, Idaho Operations Office

Signature sheet for the foregoing Central Facilities Area Landfills I, II, and III at the Idaho National Engineering Laboratory Record of Decision between the U.S. Department of Energy and the U.S. Environmental Protection Agency, with concurrence by the Idaho Department of Health and Welfare.

Chuck Clarke 9/28/95

Chuck Clarke
Regional Administrator, Region 10
U.S. Environmental Protection Agency

Date

Signature sheet for the foregoing Central Facilities Area Landfills I, II, and III at the Idaho National Engineering Laboratory Record of Decision between the U.S. Department of Energy and the U.S. Environmental Protection Agency, with concurrence by the Idaho Department of Health and Welfare.

Wallace N Cory October 19 1995

Wallace N. Cory
Administrator
Division of Environmental Quality,
Idaho Department of Health and Welfare

Date

CONTENTS

FIGURE

TABLES

ACRONYMS AND ABBREVIATIONS

ANL-W	Argonne National Laboratory-West
ARA	Auxiliary Reactor Area
ARARs	applicable or relevant and appropriate requirements
BLM	Bureau of Land Management
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFA	Central Facilities Area
CFR	Code of Federal Regulations
COCA	Consent Order and Compliance Agreement
cpm	counts per minute
CPP	Chemical Processing Plant (a.k.a. ICPP)
d	day(s)
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ESRP	Eastern Snake River Plain
FFA/CO	Federal Facility Agreement/Consent Order
FR	Federal Register
FS	feasibility study
ft	foot (feet)
g	gram(s)
gal	gallon(s)
HEAST	Health Effects Assessment Summary Tables
ICPP	Idaho Chemical Processing Plant (a.k.a. CPP)
IDHW	Idaho Department of Health and Welfare
in.	inch(es)
INEL	Idaho National Engineering Laboratory
INWMIS	Industrial Nonradiological Waste Management Information System
IRIS	Integrated Risk Information System
kg	kilogram(s)
L	liter(s)
lb	pound(s)
LDU	land disposal unit
LEL	lower explosive limit
LOFT	Loss-of-Fluid Test Facility
MCL	maximum contaminant level
mg	milligram(s)
mg/kg-d	milligrams per kilogram day
mi	mile(s)
NCP	National Contingency Plan
NPL	National Priorities List
NRF	Naval Reactors Facility
NWT	northern waste trench
OU	operable unit
pCi	picocurie(s)
PBF	Power Burst Facility
PAH	polycyclic aromatic hydrocarbon

ppm	parts per million
RAOs	remedial action objectives
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI/FS	remedial investigation/feasibility study
RME	reasonable maximum exposure
ROD	record of decision
RWMC	Radioactive Waste Management Complex
SARA	Superfund Amendments and Reauthorization Act
SF	slope factor
SRPA	Snake River Plain Aquifer
SWMU	solid waste management unit
TAN	Test Area North
TBC	to be considered
TRA	Test Reactor Area
UCL	upper confidence limit
WAG	waste area group
WRTF	Water Reactor Test Facility
WWT	western waste trench
yd^3	cubic yard(s)
yr	year(s)
μg	microgram(s)

Decision Summary

1. SITE NAME AND LOCATION

Central Facilities Area Landfills I, II, and III (Operable Unit 4-12)
and No Action Sites (Operable Unit 4-03)
Idaho National Engineering Laboratory, Idaho Falls, Idaho

The Idaho National Engineering Laboratory (INEL) is a government-operated facility managed by the U.S. Department of Energy (DOE). The INEL is located 42 mi west of Idaho Falls, Idaho, and occupies 890 mi^2 of the northeastern portion of the Eastern Snake River Plain (ESRP). The INEL encompasses portions of five Idaho counties: Butte, Jefferson, Bonneville, Clark, and Bingham. Public access to the INEL is limited to two Federal highways and three state highways that intersect the Site. The Central Facilities Area (CFA) is located in Butte county in the south-central portion of the INEL, approximately 50 mi from the larger southeastern Idaho cities of Idaho Falls and Pocatello. CFA Landfills I, II, and III are located approximately 0.5 mi north of CFA proper (Figure 1).

Current land use at the INEL is primarily nuclear research and development and waste management. Surrounding areas are managed by the Bureau of Land Management (BLM) for multipurpose use. The developed area within the INEL is surrounded by a 500-mi^2 buffer zone used for cattle and sheep grazing. Of the 10,300 people employed at the INEL, approximately 1,100 are located at CFA. The nearest off-site populations are in Atomic City (7 mi southeast of CFA), Arco (17.5 mi west of CFA), Howe (15 mi northwest of CFA), Mud Lake (32 mi northeast of CFA), and Terreton (33 mi northeast of CFA).

The INEL property is located on the northeastern edge of the ESRP, a volcanic plateau that is primarily composed of volcanic rocks and relatively minor amounts of sedimentary interbeds. The basalts immediately below the CFA are relatively flat, and are covered by 20 to 30 ft of alluvium.

The depth to the Snake River Plain Aquifer (SRPA) underlying the INEL varies from 200 ft in the northern portion to 900 ft in the southern portion. The depth to the SRPA at CFA is about 480 ft. Flow of the aquifer in this region is generally to the south-southwest.

The INEL has semidesert characteristics with hot summers and cold winters. Normal annual precipitation is 9.1 in./yr, with estimated evapotranspiration of 6 to 9 in./yr. The only surface water present at the INEL is the Big Lost River, which is approximately 1.5 mi northwest of the CFA landfills at its nearest point. Due to irrigation diversions upstream and semi-arid climate, the river is typically dry. The only naturally occurring surface water at CFA results from heavy rainfall or snowmelt, usually during the period from January to April.

Twenty distinctive vegetative types have been identified at the INEL. Big sagebrush is the dominant species, covering approximately 80% of the ground surface. The variety of habitats on the INEL support numerous species of reptiles, birds, and mammals. Several bird species at the INEL that warrant attention because of sensitivity to disturbance or their threatened status

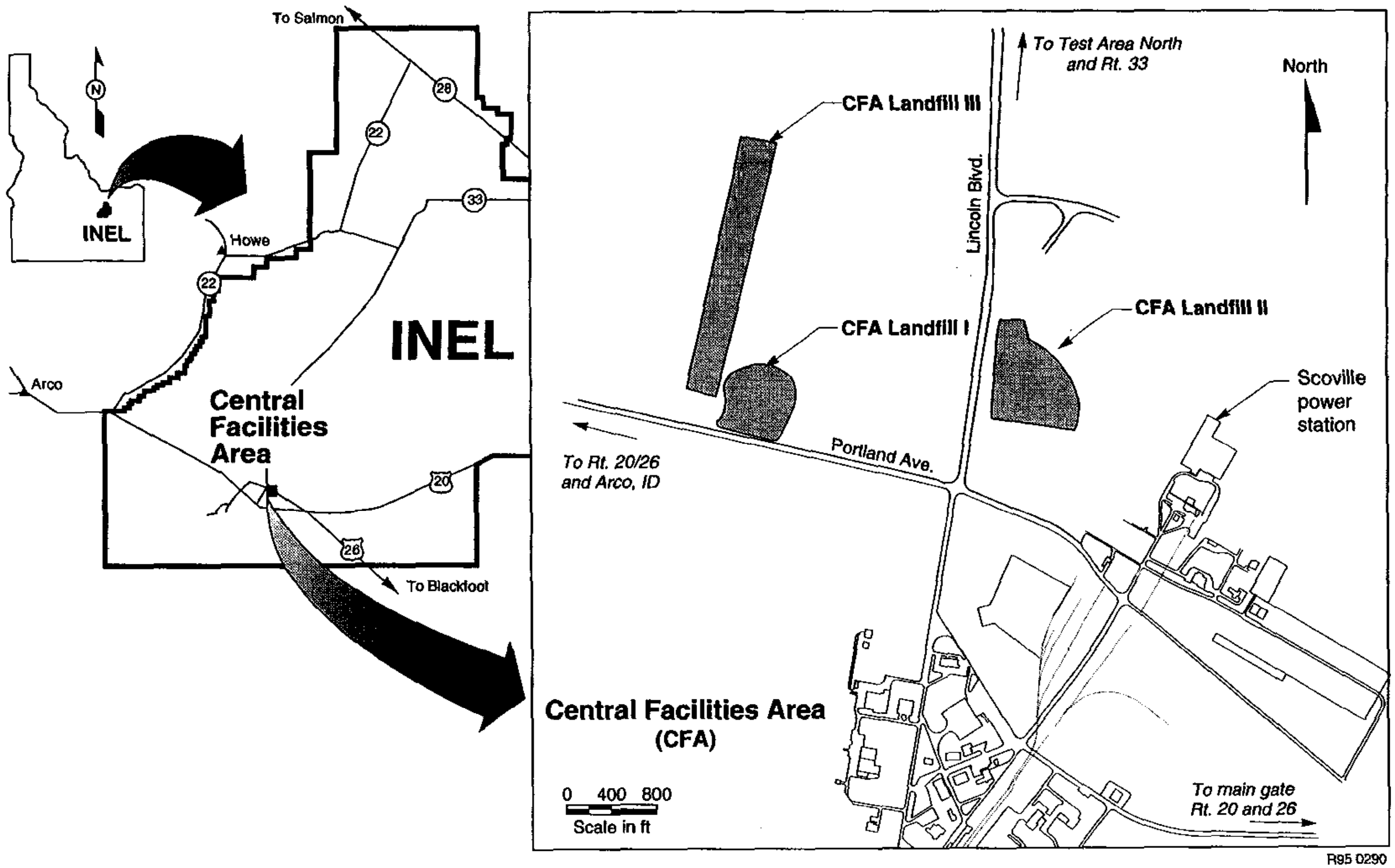


Figure 1. Location of CFA Landfills I, II, and III at the Idaho National Engineering Laboratory.

include the ferruginous hawk *(Buteo regalis)*, bald eagle *(Haliaeetus leucocephalus)*, long-billed curlew *(Numenius americanus)*, and the loggerhead shrike *(Lanius Ludovicianus)*. In addition, the Townsend's big-eared bat *(Plecotus Townsendii)* and pygmy rabbit *(Brachylagus Idahoensis)* are listed by the U.S. Fish and Wildlife Service as candidates for consideration as threatened or endangered species. The ringneck snake, whose occurrence is considered to be INEL-wide, is listed by the Idaho Department of Fish and Game as a Category C sensitive species.

CFA Landfill I was operated as a disposal facility from the early 1950s until the mid 1980s. The landfill covers a total surface area of approximately 8.25 acres. The landfill is composed of three major units, commonly referred to as the rubble landfill, the western waste trench, and the northern waste trench. CFA Landfill II, in use from 1970 until 1982, was a fill operation encompassing 15 acres in the southwestern portion of an abandoned gravel pit. CFA Landfill III, encompassing 12 acres, was opened in October of 1982, when operations at CFA Landfill II were terminated, and continued as a cut-and-fill operation until December 1984 when it also was terminated. An expansion to Landfill III was opened west of the original Landfill III and continued to handle the same types of waste. It was operational until 1993 and is no longer in use. This expansion to Landfill III is not considered part of OU 4-12 because it was still operational when this investigation began, and therefore is outside the scope of this ROD. All further references to Landfill III refer to that portion of Landfill III (original six trenches) operational prior to December 4, 1984.

The predominant waste types entering the landfills were construction, office, and cafeteria waste. Review of the waste inventory records indicate that the major types of waste accepted at the landfills include trash sweepings, cafeteria garbage, wood and scrap lumber, masonry concrete, scrap metal, weeds and grass, dirt and gravel, asphalt, and asbestos. To a lesser extent, potentially hazardous wastes were also disposed to the landfills such as waste oil, solvents, chemicals, and paint. Information regarding the types and amounts of potentially hazardous wastes disposed to the landfills is not complete due to incomplete waste disposal inventory records.

2. SITE HISTORY AND ENFORCEMENT ACTIVITIES

The original facilities at CFA were built in the 1940s and 1950s to house Naval Gunnery Range personnel. The facilities have been modified over the years to fit the changing needs of the INEL and now provide four major types of functional space: craft, office, service, and laboratory. The CFA landfills were operated as municipal-type landfills for the INEL from the early 1950s until the mid 1980s.

The Resource Recovery Act (enacted in 1970) initially governed the landfill activities. In 1976, the Resource Conservation and Recovery Act (RCRA) was enacted, with subsequent regulations governing landfills promulgated in 1980. A Consent Order and Compliance Agreement (COCA) was signed by DOE, the U.S. Geological Survey, and the U.S. Environmental Protection Agency (EPA) in 1987 that specified a RCRA corrective action program for INEL solid waste management units (SWMUs) under RCRA authority. A key element of the COCA was the identification of all known SWMUs within the INEL, including a specific subset designated as land disposal units (LDUs). SWMUs at the INEL were identified as LDUs if it was known or strongly suspected that RCRA hazardous wastes or radioactive-RCRA hazardous wastes (mixed wastes) were managed or placed at the unit in a manner constituting land disposal after the cutoff date of November 19, 1980. CFA Landfill I was classified as a SWMU because it was suspected that RCRA hazardous wastes were not routinely disposed after the cutoff date. CFA Landfills II and III were identified as LDUs because it was suspected that hazardous wastes were disposed after the cutoff date.

On July 14, 1989, EPA proposed placing the INEL on the National Priorities List (NPL) of the National Contingency Plan (NCP) (54 FR 29820) (EPA, 1990a). This was done using Hazard Ranking System procedures found in the NCP. The INEL's score was 51.91 (sites scoring 28.5 or greater are eligible for the NPL) based in part on releases of contaminants to the groundwater at two facilities: Test Reactor Area (TRA) and Test Area North (TAN). Data that support listing the INEL as an NPL site are found in the Federal Facilities Docket, EPA Headquarters, Washington, D.C. After considering public input during a 60-day comment period following the proposed INEL listing, EPA issued a final rule listing the INEL Site. The rule was published in the Federal Register (FR 29820), November 21, 1989.

Subsequent to listing the INEL on the NPL and with the development of the Federal Facility Agreement/Consent Order (FFA/CO) and the Action Plan (effective date December 9, 1991), DOE, EPA, and the Idaho Department of Health and Welfare (IDHW) decided that the CFA landfills should be evaluated under the authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The status of LDUs was discussed in detail among DOE, EPA, and IDHW during the initial negotiations of the FFA/CO in 1991, and rationale for reclassifying LDUs to SWMUs was made. The results of the negotiations are summarized in a letter from DOE to IDHW and finalized in the FFA/CO. Under the new guidelines, a unit retained its RCRA LDU designation only if known RCRA hazardous waste was routinely or systematically disposed after November 19, 1980. Consequently, many units lost their RCRA LDU status if disposal of RCRA hazardous waste was a one-time event or where knowledge of the event was based on conjecture or hearsay. Landfills II and III lost their LDU status based on this rationale.

With respect to Landfill I, investigation conducted during the RI revealed a logbook maintained by landfill operators that contained disposal records for waste disposed to Landfill I from 1981 through 1984. Review of this logbook indicated that the major types of waste accepted at this landfill during that time period included trash sweepings, cafeteria garbage, wood and scrap lumber, masonry concrete, scrap metal, weeds and grass, dirt and gravel, asphalt, and asbestos. To a lesser extent, potentially hazardous wastes were also disposed to the landfill such as paint, resins, sludge, and chemicals. However, because there was no conclusive evidence that RCRA hazardous wastes were disposed to Landfill I after November 19, 1980, Landfill I was not classified as a RCRA LDU.

A Track 2 investigation was performed on Landfill I under the FFA/CO. A recommendation was made in the Track 2 investigation to further evaluate the groundwater and air pathways of Landfill I as part of the OU 4-12 Remedial Investigation/Feasibility Study (RI/FS). The primary source of information on Landfill I is the *Preliminary Scoping Track 2 Summary Report for Operable Unit 4-10* (Trippet et al., 1995). A copy of this report can be found in the Administrative Record for Waste Area Group (WAG) 4. This ROD documents the results of the RI/FS and the selected remedy for CFA Landfills I, II, and III.

3. HIGHLIGHTS OF COMMUNITY PARTICIPATION

In accordance with CERCLA § 113(k)(2)(B)(i-v) and 117, a series of opportunities for public information and participation in the remedial investigation and decision process for the CFA landfills were provided to the public from August 1993 through May 1995. For the public, the activities ranged from receiving a fact sheet that briefly discussed the CFA landfills investigation to date, *INEL Reporter* articles and updates, and a proposed plan, to conducting a telephone briefing and public meetings.

In August 1993, a fact sheet concerning the CFA landfills remedial investigation was sent to about 6,700 individuals of the general public and 650 INEL employees on the INEL Community Relations Plan mailing list.

Informal open house meetings on the CFA landfills remedial investigation were held August 11 and 12, 1993, in Pocatello and Twin Falls, respectively. Public information meetings on the CFA landfills remedial investigation were also held on August 17, 18, and 19, 1993, in Idaho Falls, Boise, and Moscow, respectively. During these meetings, representatives from DOE and INEL discussed the project, answered questions, and listened to public comments. Comments from the information meetings were evaluated and considered as part of the RI/FS process.

Regular reports concerning the status of the CFA landfills project were included in the *INEL Reporter* and mailed to those who attended the meetings and who were on the mailing list. Reports appeared in six issues of the *INEL Reporter* and three *Citizens' Guides*.

In April 1995, a fact sheet concerning the CFA landfills was sent to about 6,700 individuals of the general public and 650 INEL employees on the INEL Community Relations Plan mailing list. On April 11, 1995, the DOE issued a news release to more than 100 news media contacts concerning the beginning of a 30-day public comment period, which began April 26, 1995 and ended May 26, 1995, pertaining to the CFA Proposed Plan. Both the fact sheet and news release gave notice to the public that CFA documents would be available before the beginning of the comment period in the Administrative Record section of the INEL information repositories located in the INEL Technical Library of Idaho Falls, the INEL Boise Office, as well as in public libraries in Idaho Falls, Fort Hall, Pocatello, Twin Falls, Boise, and Moscow.

Opportunities for public involvement in the decision process for the CFA landfills were provided beginning in April 1995. For the public, the activities ranged from receiving the proposed plan, conducting one teleconference call, and attending open houses and public meetings to informally discuss the issues and offer verbal and written comments to the agencies during the 30-day public comment period.

Copies of the proposed plan for the CFA landfills were mailed to about 6,700 members of the public and 650 INEL employees on the INEL Community Relations Plan mailing list on April 24, 1995, urging citizens to comment on the proposed plan and to attend public meetings. Display advertisements announcing the same information and the location of public meetings on May 16, 17, and 18, 1995, in Idaho Falls, Boise, and Moscow, respectively, appeared in seven major Idaho newspapers. Large advertisements appeared in the following newspapers on April 26: *Post Register* (Idaho Falls); *Idaho State Journal* (Pocatello); *South Idaho Press* (Burley); *Times News*

(Twin Falls); *Idaho Statesman* (Boise); *Lewiston Morning Tribune* (Lewiston); and *The Daily News* (Moscow).

A post card was mailed on May 10, 1995, to about 6,700 members of the public and 650 INEL employees on the INEL Community Relations Plan mailing list to encourage them to attend the public meetings and provide verbal or written comments. Both media, the news release and newspaper advertisements, gave public notice of public involvement activities and offerings for briefings, and the beginning of a 30-day public comment period that was to begin April 26 and run through May 26, 1995.

Written comment forms, including a postage-paid business reply form, were made available to those attending the public meetings. The forms were used to turn in written comments at the meeting and, by some, to mail in comments later. For those who did not attend the public meetings but wanted to make formal written comments, a written comment form was attached to the Proposed Plan. The reverse side of the meeting agenda contained a form for the public to evaluate the effectiveness of the meetings. A court reporter was present at each meeting to keep verbatim transcripts of discussions and public comments. The meeting transcripts were placed in the Administrative Record section for the CFA landfills, Operable Unit (OU) 4-12, in eight INEL information repositories.

A total of about 10 people (other than agency representatives) attended the CFA landfills public meetings. Overall, eight provided formal comment; of these eight people, three provided oral comments and five provided written comments. All comments received on the proposed plan were considered during the development of this ROD. The decision for this action is based on the information in the Administrative Record for this OU.

A Responsiveness Summary has been prepared as part of the ROD. All formal verbal comments, as given at the public meetings, and all written comments, as submitted, are repeated verbatim in the Administrative Record for the ROD. Those comments are annotated to indicate which response in the Responsiveness Summary addresses each comment.

On August 2, 1995, project managers from the Idaho Department of Health and Welfare Division of Environmental Quality gave a brief presentation on the project to the Environmental Management Site Specific Advisory Board—INEL. The advisory board is a group of individuals representing the citizens of Idaho, making recommendations to DOE, EPA, and the state of Idaho regarding environmental restoration activities at the INEL.

4. SCOPE AND ROLE OF OPERABLE UNIT AND RESPONSE ACTIONS

Under the FFA/CO, the INEL is divided into ten WAGs. The WAGs are further divided into OUs. The CFA has been designated WAG 4, and consists of 13 OUs. OU 4-12 consists of the wastes disposed to the three landfills and the associated soil impacted by the landfills. Data from shipping records, along with process knowledge, written correspondence, and interviews with current and previous employees, and monitoring and sampling data were used to evaluate the CFA landfills OU 4-12.

A complete evaluation of all cumulative risks associated with CERCLA actions at WAG 4 will be conducted as part of the WAG 4 Comprehensive RI/FS (OU 4-13) to ensure that all risks have been adequately evaluated.

5. SUMMARY OF SITE CHARACTERISTICS

The following sections provide a summary of the physical characteristics of the CFA landfills as well as a description of the wastes disposed to the landfills, and a summary of the contaminants present in various media associated with the landfills. Greater detail may be found in the "Remedial Investigation/Feasibility Study for Operable Unit 4-12: Central Facilities Area Landfills I, II, and III at the Idaho National Engineering Laboratory."

5.1 Physical Characteristics of the CFA Landfills

The CFA landfills are located on the ESRP in Big Lost River alluvial deposits overlying basalt bedrock. The sediments comprising these deposits are primarily sands and gravels and contain very few fine-grained materials. In some places, however, a clay-rich layer (0 to 9 ft thick) exists above the bedrock. Depth to basalt at these landfills ranges from 10 to 37 ft. The vadose zone, that portion of the subsurface that extends from the land surface down through the subsurface to the water table, at the CFA landfills is approximately 480 ft thick. It is composed of a relatively thin layer of surface sediments, in which the wastes are disposed, and thick sequences of interfingering basalt flows containing interbedded sediments. As a result of the relatively low annual precipitation, high potential evapotranspiration, and deep water table, vadose zone soils at the landfills tend to be relatively dry during most of the year. The SRPA, one of the largest and most productive groundwater resources in the United States, underlies the CFA landfills. The aquifer is listed as a Class I aquifer, and EPA has recently designated it as a sole source aquifer. The SRPA consists of a series of saturated basalt flows and interlayered pyroclastic and sedimentary materials that underlie the ESRP. The depth to water at the CFA landfills varies from about 476 ft to just over 495 ft. The direction of groundwater flow in this general vicinity is in a south to southwesterly direction.

5.1.1 Landfill I

Landfill I occupies a total surface area of approximately 8.25 acres, and consists of three subunits: the rubble landfill, western waste trench, and northern waste trench. The rubble landfill originated as a gravel quarry that was operated by the U.S. Navy from 1942 to 1949. The quarry was used as a disposal area for Site-wide waste disposal sometime after 1949. The surface area of the rubble landfill is estimated to be 5.5 acres, and its depth is estimated to be 12 to 15 ft. The rubble landfill is covered with approximately 1 to 5 ft of soil overlain with a layer of gravel. The surface of the western waste trench is approximately 2 acres, consisting of smaller waste trenches, each excavated to a size of 8 ft wide by 10 ft deep by 50 ft long. Each of the smaller trenches is separated from the other by 15 ft of undisturbed soil. Filled trenches were covered with 1 to 5 ft of soil. The northern waste trench was identified from aerial photographs and has a surface area of approximately 0.75 acres. Information pertaining to its true dimensions is limited. Currently, it is covered with soil and is undiscernible at the surface.

5.1.2 Landfill II

Landfill II encompasses approximately 15 acres and is located in the southwest corner of an abandoned gravel pit. Depth to basalt at the landfill varies from 15 to 37 ft based on a seismic refraction survey and a subsurface borehole drilling investigation. The landfill waste profile, however, is estimated to range in depth from 12 to 28 ft because the pit probably was not excavated beyond the base of the gravel-bearing unit and into the clay material. Hand augering at 60 sampling sites indicated that the Landfill II soil cover ranges in thickness from 0.33 to 3.17 ft, with an overall mean of 1.50 ft. The landfill surface is gently undulating due to differential settling of the waste and maintains a stand of crested wheatgrass.

5.1.3 Landfill III

Landfill III consists of six trenches that cover approximately 12 acres. Depth to the underlying basalt is 10 to 33 ft based on a seismic refraction survey. The landfill waste profile is estimated to be 13 ft deep on average. It was common practice to excavate the landfill trenches, leaving a soil layer intact between the waste and underlying basalt. The Landfill III soil cover ranges in thickness from 1 to 8 ft with an overall mean of 2.83 ft, based on augering results. Ground-penetrating radar measurements indicate the average soil cover thickness to be 2 to 3 ft. The landfill surface is also gently undulating due to differential settling of the waste and maintains a stand of crested wheatgrass.

5.2 Landfill Waste Description

Contaminant sources in the CFA landfills can be generally described as solid and liquid nonradioactive materials disposed to the landfills over the past 40 years. The predominant waste types entering the landfills were construction, office, and cafeteria waste. Review of the waste inventory records indicate that the major types of waste accepted at the landfills include trash sweepings, cafeteria garbage, wood and scrap lumber, masonry concrete, scrap metal, weeds and grass, dirt and gravel, asphalt, and asbestos. To a lesser extent, potentially hazardous wastes were also disposed to the landfills and may include waste oil, solvents, chemicals, and paint. Landfill waste descriptions have been determined from the Industrial Nonradioactive Waste Management Information System (INWMIS), interviews with site personnel, reports, and other information related to waste disposal. Many uncertainties (especially with Landfill I) are associated with the data gathered from these sources, including lost or unreadable records, overestimation and/or underestimation of waste volumes, and inconsistency in actual disposal locations. Although the reliability of the waste descriptions may not be very high, the waste descriptions do indicate the general categories of waste typically disposed to these landfills.

Solid nonradioactive materials disposed in the CFA landfills were generated by INEL facilities including the following: Argonne National Laboratory-West (ANL-W), Auxiliary Reactor Area (ARA), CFA, Idaho Chemical Processing Plant (ICPP), Experimental Breeder Reactor II, Naval Reactors Facility (NRF), Special Power Excursion Reactor Test, TAN, and TRA. Material was collected by the Central Facilities Maintenance Branch of the Site Services Division. Demolition and construction materials were disposed to the landfill directly by subcontractors responsible for a given project. Records show no indication of material segregation within the landfills. To a lesser extent, the disposal of liquid wastes in a sludge form, including oils, solvents, and other chemicals did occur, usually by spreading upon the day's collection of solid wastes, compacting, and covering with at least 1 ft of natural soil cover. During operation of CFA Landfills II and III (1970 to 1984), screening procedures were in place to prevent radioactive wastes from being inadvertently deposited in the landfills during their operation. Screening was the responsibility of the generating facility. Prior to disposal of any waste material at the CFA landfills, the waste was screened by a radiological control technician for beta- and gamma-emitting radionuclides and for alpha-emitting radionuclides to determine if the waste material was above radioactive background levels. However, it is acknowledged that up to one shipment per month containing low levels of radioactive waste may have been inadvertently disposed to the landfills; wastes were not screened for radioactivity at the time of disposal on a full-time basis at INEL landfills until 1989.

5.2.1 Landfill I and Subunits

This section discusses the waste disposal practices at Landfill I, which consists of three subunits: rubble landfill, western waste trench, and northern waste trench. Estimates of waste volume and type were made from the landfill logbooks, interviews with site personnel, and INWMIS, assuming the waste characteristics were similar for Landfill I to those recorded for Landfills II and III, since INWMIS does not contain information regarding disposals to Landfill I.

Rubble Landfill. The rubble landfill originated as a gravel quarry that was operated by the U.S. Navy from 1942 to 1949. In 1949, construction of the National Reactor Testing Station (now the INEL) began, and the quarry continued to be used as a gravel source. The quarry was used as a disposal area for Site-wide solid waste sometime after 1949. Waste disposal practices at the rubble landfill consisted of disposal of waste to the open gravel quarry, infrequent compaction with earth-moving equipment, and covering with available soil material. Soil covering was not performed consistently and probably only when areas were filled with waste. It is also known, based on interviews with knowledgeable personnel, that open burning of flammable wastes occurred before covering. Additionally, landfill personnel would use disposed flammable liquids to ignite wastes.

An incinerator, located adjacent to the landfill, operated from 1951 to 1957. It was used to incinerate classified documents and other paper waste. Paper waste was brought to the incinerator by truck and was burned. The waste ash was disposed to the rubble landfill.

Review of landfill disposal logbooks indicate that disposal of wastes also occurred from late 1981 through 1984 in the rubble landfill in an area known to workers at the time as the "east hole." The "east hole" is an L-shaped pit located within the rubble landfill south of the quarry spoil pile. It was noted during personnel interviews that a dumping area for several empty acid storage tanks referred to as the "acid pit" was also located in this area. Interviews with personnel indicate that the Navy disposed of waste, including shell casings, in the north end of the rubble landfill. Tables 1 and 2 summarize the wastes including volume estimates by waste types disposed to the rubble landfill for the periods from the 1950s to 1970 and from 1982 to 1984, respectively.

Western Waste Trench. Waste disposal practices at the western waste trench (WWT) consisted of disposal of waste to an open area of six smaller trenches. The waste was ignited inside the trench and covered with soil periodically. According to interviews with site personnel, flammable liquids were used to improve combustion of wastes. Table 3 summarizes the wastes including volume estimates by waste types disposed to the western waste trench of CFA Landfill I.

Table 1. Estimated waste volumes for Landfill I, rubble landfill from mid-1950s to 1970.

Waste type	Percent of total volume	Total volume (yd^3)	Assumptions
1. Trash, sweepings	0%	0	Trash and sweepings were burned openly in WWT or NWT
2. Cafeteria Garbage	0%	0	Cafeteria garbage was primarily disposed in WWT or NWT
3. Wood, scrap lumber	5%	6,550	Wood and scrap lumber were burned openly or salvaged by employees
4. Masonry, concrete	85%	111,389	Primary waste disposed from construction and demolition projects
5. Scrap metal	5%	6,550	Waste disposed from construction and demolition projects
6. Weeds, grass, trees	1%	1,308	Same percentage of total volume as Landfill II
7. Dirt, gravel	1%	1,308	Similar percentage of total volume as Landfill II and process knowledge
8. Asphalt	1%	1,308	Same percentage of total volume as Landfill II
9. Asbestos	1%	1,308	Same percentage of total volume as Landfill II
10. Other	1%	1,308	Same percentage of total volume as Landfill II
Waste oil, waste oil sludge, liquid wastes including paint thinner, paint, solvents	0%	0	This type of waste was not disposed to the rubble landfill according to site personnel. Waste oil was burned openly, used for dust suppression on roads, or disposed to the WWT or NWT according to interviews with site personnel. Liquid (i.e., solvent waste) was burned in the WWT and NWT.
Fire extinguishers (1,1,2-trifluorotrichloroethane)	Unknown	Unknown	Fire extinguishers were disposed to rubble landfill according to interviews with site personnel.

Table 2. Estimated waste volumes for Landfill I, rubble landfill from 1982 to 1984 (estimates based on Landfill I logbook).

Waste type	Total volume (yd^3)
1. Trash, sweepings	1,229
2. Cafeteria garbage	57
3. Wood, scrap lumber	5,444
4. Masonry, concrete	3,730
5. Scrap metal	213
6. Weeds grass, trees	180
7. Dirt, gravel	1,610
8. Asphalt	4,047
9. Asbestos	43
10. Other	134
Boxes of hazardous material	37
Sludge	10
Slag	2
Conductors	4
Tires	10
Resins	4
Lagging	11
Barrels/buckets/drums	248
Roofing	133
Insulation	306
Gilsolate/gilsotherm	9
Paint	28
Acid tanks	2 empty tanks
Rocks	87
Sodium nitrate	2
Calcium nitrate	2
Sump sludge	2

Table 3. Estimated waste volumes for Landfill I, western waste trench.

Waste type	Percent of total volume	Total volume (yd^3)	Assumptions
1. Trash, sweepings	74%	7,026	Same percentage of total volume as Landfill II
2. Cafeteria garbage	11%	1,045	Same percentage of total volume as Landfill II
3. Wood, scrap lumber	0%	0	Disposed to rubble landfill
4. Masonry, concrete	0%	0	Disposed to rubble landfill
5. Scrap metal	0%	0	Disposed to rubble landfill
6. Weeds, grass, trees	<1%	95	Same percentage of total volume as Landfill II
7. Dirt, gravel	2%	190	Same percentage of total volume as Landfill II
8. Asphalt	0%	0	Disposed to rubble landfill
9. Asbestos	<1%	95	Same percentage of total volume as Landfill II
10. Other	1%	95	Same percentage of total volume as Landfill II
Waste oil, waste oil sludge, paint thinner, paint, solvents	10%	850	Waste oil was burned openly, used for dust suppression on roads, or disposed to the WWT or NWT according to interviews with site personnel. Liquid (i.e., solvent waste) was burned in the WWT and NWT.

Northern Waste Trench. Information on disposal practices for the northern waste trench (NWT) is not available; however, practices were probably similar to that of the WWT. Table 4 summarizes the wastes including volume estimates of waste types disposed to the NWT of CFA Landfill I.

5.2.2 Landfill II

Landfill II operated from September 1970 to September 1982. It occupies the southwest corner of an existing gravel pit that opened in the early 1950s. Waste disposal began in September of 1970 in the far southwest corner of the pit. It was standard practice for a single operator to be assigned to the landfill during the day to receive and log in waste. Waste was placed in the landfill randomly or in "low spots" and was then compacted by a D-8 caterpillar tractor into layers or cells that were 12 to 24 in. thick. The compacted waste was covered with approximately 1 ft of coarse soil material (sandy gravel) at the end of the day. Material for the intermediate cover was scraped from the bottom of the pit and from a previously unexcavated area north of the landfill. After the landfill operation ceased, overburden material, previously stockpiled during the opening of the pit, was used for cover material.

During the early 1970s, asbestos was placed in the bottom of the pit at Landfill II. The asbestos was normally covered with waste and then covered with fill material at the end of the day. By the late 1970s, disposal practices for asbestos were modified to require double bagging or boxing. According to site personnel, solvent sludges and chemical wastes were disposed at the landfill. These materials may have been absorbed onto rags and containerized or dumped directly onto the day's collection of solid waste. Personnel interviews also indicate that most of the drums disposed to the landfill were empty; occasionally, however, drums containing material (soaked rags and/or diatomaceous earth) were also disposed. Waste oils were disposed in the landfill; however, according to the personnel interviews, a significant amount of the waste oil was used on the roads for dust suppression throughout the 1970s and 1980s. Cooling tower wood from the Materials Test Reactor at the TRA potentially contaminated with chromates was also disposed in the landfill. According to personnel interviews, there was no open burning of wastes in Landfill II. Table 5 summarizes the wastes including volume estimates by waste types disposed to CFA Landfill II.

5.2.3 Landfill III

Landfill III opened in October 1982 after Landfill II was closed, and operated as a cut-and-fill trench until December 1984. Waste was placed in the six trenches as they were excavated. The eastern-most trench was the first to be excavated and was started from the south end with a trench 24 ft wide. The excavation proceeded from south to north on the first trench with overburden material being pushed to the sides. Excavation of the second trench then proceeded from north to south again with the overburden material being pushed to the sides. All six trenches in the landfill were excavated in this manner.

The logbook maintained by landfill personnel was reviewed to provide insight into the types of waste and disposal point locations in Landfill III. Similar to Landfill II, personnel interviews indicate that no open burning of waste in Landfill III was conducted. For the most part, asbestos was placed in the "asbestos pit" immediately north of Landfill III rather than in the Landfill III

Table 4. Estimated waste volumes for Landfill I, northern waste trench.

Waste type	Percent of total volume	Total volume (yd^3)	Assumptions
1. Trash, sweepings	74%	4,862	Same percentage of total volume as Landfill II
2. Cafeteria garbage	11%	772	Same percentage of total volume as Landfill II
3. Wood, scrap lumber	0%	0	Disposed to rubble landfill
4. Masonry, concrete	0%	0	Disposed to rubble landfill
5. Scrap metal	0%	0	Disposed to rubble landfill
6. Weeds, grass, trees	1%	65	Same percentage of total volume as Landfill II
7. Dirt, gravel	2%	131	Same percentage of total volume as Landfill II
8. Asphalt	0%	0	Disposed to rubble landfill
9. Asbestos	1%	65	Same percentage of total volume as Landfill II
10. Other	1%	65	Same percentage of total volume as Landfill II
Waste oil, waste oil sludge, liquid wastes including paint thinner, paint, and solvents	10%	588	Waste oil was burned openly, used for dust suppression on roads, or disposed to the WWT or NWT according to interviews with site personnel. Liquid (i.e., solvent waste) was burned in the WWT and NWT.

Table 5. Estimated waste volumes for CFA Landfill II.

INWMIS waste category	Type of waste	Source	Solid volume (yd^3)	Solid weight (lb)	Liquid volume (gal)
1. Trash and sweepings	- Office trash, paper, cardboard, plastic, glass, etc.	- INEL Facilities, dumpster containers	285,308		275
2. Cafeteria garbage	- Used grease - Soybean oil - Vegetable oil - Food waste - Up to 70% moisture	- ANL, CFA, CPP, NRF, RWMC, TAN, TRA	40,528		
3. Wood and scrap lumber	- Wood and scrap lumber - Scrap lumber	- INEL Facilities, dumpster containers	19,078		
4. Masonry, concrete	- Used masonry - Used concrete	- ANL, ARA, CFA, CPP, NRF, PBF, RWMC, TAN, TRA, WRTF	17,637		
5. Scrap metal	- Scrap metal - Scrap metal from welding, pipe fitting - Sheet metal operations - Metal vehicle parts including wheels, mufflers, bearings, vehicle batteries, etc.	- ANL, ARA, CFA, CPP, NRF, PBF, RWMC, TAN, TRA, WRTF	7,154		
6. Weeds, grass, trees	- Weeds, grass, and trees from landscape maintenance operations	- ARA, CFA, CPP, NRF, RWMC, TRA	435		
7. Dirt, gravel	- Dirt, gravel	- ARA, CFA, CPP, NRF, PBF, TRA	6,415		
8. Asphalt	- Used asphalt	- ANL, ARA, CFA, CPP, NRF, PBF, TRA	2,103		
9. Asbestos	- Asbestos - Asbestos coated materials such as pipes, etc.	- ANL, CFA, NRF, PBF, TAN, TRA	807		

Table 5. (continued).

INWMIS waste category	Type of waste	Source	Solid volume (yd^3)	Solid weight (lb)	Liquid volume (gal)
10. Other	- Asphalt and dirt	- CFA, NRF	973		
	- Asphalt and concrete	- ANL	19		
	- Asphalt and gravel	- NRF, TRA	20		
	- Asphalt, dirt, and concrete	- NRF	20		
	- Asphalt, grass, and dirt	- CFA	7		
	- Asphalt, ground, sod, and rock	- NRF	28		
	- Barrels, crates	- CPP	6		
	- Buckets	- CPP	11		
	- Building material	- NRF	1		
	- Cans and bottles	- CFA	1		
	- Construction materials	- NRF	129		
	- Construction waste	- NRF	3,014		
	- Dead deer	- TRA	1		
	- Dirt and rock(s)	- CFA, RWMC	105		
	- Dirt barrels	- CPP	130		
	- Dirt, logs	- PBF	5		
	- Grass, weeds, and roofing material	- CFA	66		
	- Hyplon	- NRF	1		
	- Lumber and concrete	- NRF	6		
	- Mixed gravel and scrap metal	- RWMC	7		
	- Paper, barrels, and tire	- TRA	1		
	- Plants, dirt, and concrete	- NRF	6		
	- Siding	- ANL	2		

Table 5. (continued).

INWMIS waste category	Type of waste	Source	Solid volume (yd^3)	Solid weight (lb)	Liquid volume (gal)
	- Sod and dirt	- TRA	26		
	- Soot, rocks, and roofing materials	- PBF	20		
	- Structure consisting of wood, metal, and glass	- TRA	24		
	- Tar, buckets, plastic, and metal	- ANL	2		
	- Unknown (not specified)	- ARA, CFA, CPP, TAN	265		
	- Visqueen, dirt	- CPP	7		
	- Weeds, dirt	- CPP	5		
	- Weeds, grass, asphalt, and dirt	- CFA	48		
	- Weeds, barrels	- CPP	4		
96. Oil	- Waste oil sludge	- NRF			4,790
	- Waste oil sludge and scrap	- NRF			2,928
97. Solvents	- Carbon tetrachloride	- NRF			0.5
	- Paint	- NRF			25
	- Paint thinner	- NRF			105
	- Solvents	- NRF			54
98. Chemicals	- Asphalt lead	- CPP	10		
	- Antifreeze absorbed on Oil Dri	- ANL	1		
	- Beryllium chips	- TAN	1		
	- Boric acid	- ANL		480	
	- Boron solution	- NRF			2,100
	- Calcium chloride	- CFA	14		
	- Calcium hypochlorite	- CFA		160	
	- Chemicals	- NRF		1,686	

Table 5. (continued).

INWMIS waste category	Type of waste	Source	Solid volume (yd^3)	Solid weight (lb)	Liquid volume (gal)
	- Cr +3	- ANL		590	
	- Chromates	- NRF, TRA	268		6,520
	- Ether	- ANL			1
	- Ethylene glycol	- ANL	268		165
	- Mercury	- TAN		4	
	- Methylene dithiocyanate	- NRF		50	
	- Misc. chemicals	- NRF		3,141	
	- Morpholine	- NRF			95
	- Paint	- CFA, NRF, TRA		2	52
	- Paint cans	- CPP	6		
	- Powdered boric acid	- TAN		2	
	- Resin	- TRA		38,767	
	- Soda ash	- NRF		9,100	
	- Sodium dichromate sludge	- ANL		15	
	- Sulfuric acid	- TAN			59
	- Used paint	- NRF			449
	- Zircalloy turnings	- ANL	1		
	- Zirconium chips	- TAN	1		

trenches; however, some nonfriable asbestos was disposed in Landfill III. According to personnel interviews, chemical or solvent disposal to Landfill III was relatively infrequent. Some of the drums disposed to the landfill did contain material or liquid absorbed on rags or diatomaceous earth, but the majority of the drums were empty upon disposal. Oil or sludge disposal to Landfill III was not noted during the personnel interviews. Table 6 summarizes the wastes including volume estimates by waste types disposed to CFA Landfill III.

5.3 Nature and Extent of Contamination

The following sections discuss the results of the site characterization conducted at each landfill to identify contaminants present in site soil, vadose zone, groundwater, and air.

5.3.1 Surface Soil

Surface soil samples were collected from the soil covers of each landfill for volatile organic, semivolatile organic, and inorganic compound analyses. Gross alpha/beta and gamma-emitting radionuclides were also analyzed for soil samples collected at CFA Landfill I. No volatile organic compounds were found in soil samples collected at Landfills I and III. A few volatile organic compounds were detected in soil collected from some locations at Landfill II, but all concentrations detected in soil collected from this landfill are all well below the risk-based screening levels. Semivolatile organic compounds, including benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene were detected in soil collected from Landfill I at concentrations ranging from 0.04 to 0.89 mg/kg and at Landfill II at concentrations ranging from 0.044 to 0.92 mg/kg. These compounds are commonly referred to as polycyclic aromatic hydrocarbons (PAHs); compounds found in asphalt or petroleum distillates, common wastes disposed in the landfills. Inorganic data from the landfills' cover soils were compared to naturally occurring background concentrations for INEL soils. Inorganics above naturally occurring background levels at Landfill I include beryllium, chromium, lead, silver, and zinc. The inorganics chromium, lead, silver, and zinc were detected at concentrations well below the risk-based screening levels. Inorganic analyte concentrations detected at Landfills II and III were within the common range expected for soils of this area. Cobalt-60 was the only radionuclide detected at Landfill I at one sample location above background concentrations.

In summary, contaminants of concern identified for CFA Landfill I include beryllium, cobalt-60, and benzo(a)pyrene; a few PAHs at concentrations of less than 1 mg/kg at Landfill II; and no contaminants of concern were identified in the surface soils from the cover of Landfill III.

5.3.2 Subsurface Soil Sampling of Landfill II

Seven boreholes were drilled into the waste to the top of the underlying basalt layer at Landfill II to (a) determine the nature and concentration of leachable contaminants within and below the waste unit, and (b) determine if leachate is present in or below the landfill. Soil samples were collected within and below the waste unit for volatile organic, semivolatile organic, and inorganic compound analyses. The drilling investigation indicated the presence of PAHs (compounds present in asphalt or petroleum products) at concentrations ranging from 0.15 to 0.75 mg/kg within the waste unit of Landfill II and correlates with the waste inventory evaluation. This suggests that the major types of waste that are present in quantities that appear to pose

Table 6. Estimated waste volumes for CFA Landfill III. (The INWMIS volume estimates for Landfill III have been adjusted to reflect that waste was also disposed to the rubble landfill from 1982 to 1984.)

INWMIS waste category	Type of waste	Source	Solid volume (yd^3)	Solid weight (lb)	Liquid volume (gal)
1. Trash and sweepings	- Office trash, paper, cardboard, plastic, glass, etc.	- ANL, ARA, CFA, CPP, NRF, PBF, RWMC, TAN, TRA, WRTF	44,984		125
2. Cafeteria garbage	- Used grease	- ANL, CFA, CPP, NRF, TAN, TRA	9,339		
	- Soybean oil				
	- Vegetable oil				
	- Food waste				
	- Up to 70% moisture				
3. Wood and scrap lumber	- Wood and scrap lumber	- ANL, ARA, CFA, CPP, LOFT, NRF, PBF, RWMC, TAN, TRA, WRTF	3,947		
	- Scrap lumber				
4. Masonry, concrete	- Used masonry	- ANL, CFA, CPP, NRF, PBF, RWMC, TAN, TRA, WRTF	2,211		
	- Used concrete				
5. Scrap metal	- Scrap metal	- ANL, ARA, CFA, CPP, NRF, PBF, RWMC, TAN, TRA, WRTF	809		
	- Scrap metal from welding, pipe fitting				
	- Sheet metal operations				
	- Metal vehicle parts including wheels, mufflers, bearings, vehicle batteries, etc.				
6. Weeds, grass, trees	- Weeds, grass, and trees from landscape maintenance operations	- ARA, CFA, CPP, NRF, RWMC, TRA	217		
7. Dirt, gravel	- Dirt and gravel from maintenance, construction, and demolition projects	- CFA, CPP, NRF, PBF, RWMC, TRA, WRTF	0		

Table 6. (continued).

INWMIS waste category	Type of waste	Source	Solid volume (yd^3)	Solid weight (lb)	Liquid volume (gal)
8. Asphalt	- Waste asphalt from maintenance, construction, and demolition projects	- ANL, CFA, CPP, NRF, PBF, TAN, TRA	0		
9. Asbestos	- Asbestos - Asbestos coated materials such as pipes, etc.	- ANL, CFA, CPP, NRF	88		
10. Other - must specify	- Asphalt and gravel	- CFA	1,697		
	- Barrels	- CPP	40		
	- Bucket boxes	- CPP	1		
	- Dirt and grass	- CFA	129		
	- Dirt and rock	- PBF	150		
	- Misc.	- CPP	5		
	- Outdated drugs	- CFA	1		
	- Resin barrels	- TRA	14		
	- Roofing materials, plastic barrels	- CFA	5		
	- Sod, weeds, and gravel	- CPP	11		
	- Weeds, gravel	- CPP	4		
96. Oil	- Asphalt	- RWMC			100
98. Chemicals	- Outdated medications	- CFA		6	
	- Paint in cans	- NRF			25
	- Paints	- CFA			30

potential contaminant sources include asphalt, oil, and oil sludge. Due to the heterogeneous nature of the waste and the limited number of boreholes, complete characterization of the landfills was not expected.

5.3.3 Vadose Zone Soil Gas

A shallow soil gas survey of Landfills I, II, and III was performed by collecting soil gas samples at a depth of approximately 4 ft. Soil gas samples were also collected from nine boreholes instrumented with gas ports at Landfills II and III. The gas ports ranged in depth from 12 to 31 ft. The soil gas samples were analyzed for volatile organic compounds and methane. Several volatile organic compounds were detected in gas samples collected from all three landfills at relatively low concentrations.

Methane, a common landfill gas, was not detected at Landfill I but was found at concentrations ranging from 14 to 120,000 parts per million (ppm) at Landfill II and 14 to 1,600 ppm at Landfill III in soil gas samples collected from 4 ft below the landfill surface. Methane was detected in only three of the nine boreholes sampled, and these concentrations were all below the LEL for methane of 53,000 ppm. Methane concentrations in the boreholes have decreased from previous sampling of these boreholes in 1988 and 1989. The presence of methane is indicative of the biological decomposition of the organic material (i.e., cafeteria waste) that was disposed to the landfills, and the concentrations detected are in compliance with EPA solid waste disposal facility criteria, where (a) the concentration of methane gas generated by the landfill does not exceed 25% of the LEL for methane in facility structures, and (b) the concentration of methane gas does not exceed the LEL for methane at the facility property boundary.

5.3.4 Leachate Migration

Analysis of salinity probe data collected from January 1988 to January 1991 at Landfills II and III was also conducted. During December 1987, a shallow drilling program was implemented at CFA Landfills II and III. The objectives of the program included monitoring hydraulic behavior of the landfill soil to quantify the amounts and rates of water movement into and through the soil profile. Nine boreholes (four at Landfill II and five at Landfill III) were drilled and instrumented with a total of 16 salinity probes. Salinity probes are used to measure the electrical conductance of soil water. Conductance is proportional to the dissolved solids or salts in the water. Leachate (water that has contacted the waste) from landfills is expected to be much higher in dissolved solids than natural soils. Therefore, the salinity probes were used to monitor for migration of leachate from the landfill. Data from these probes were collected on roughly a monthly basis from January 1988 to January 1991.

An evaluation of the salinity probe data indicated that the probes underwent a period of equilibration with the soil lasting until late summer of 1988. Data from salinity sensors in two boreholes at CFA Landfill III indicate that leachate migration may have occurred at these locations. Unfortunately, neither soil moisture content nor soil matric potential (also monitored at the landfills as part of this program) was measured in the vicinity of these boreholes. The additional data could have provided supporting evidence for leachate migration in the form of soil moisture levels and drainage amounts. Thirteen salinity sensors at the other seven borehole locations provided little or no indication of leachate migration. Readings were within the range of values typical for saline desert soils. It was concluded that none of the probes at Landfill II indicated migration of leachates with high dissolved solids, and three of the probes (two at the same borehole) at Landfill III indicated potential migration of leachates with high dissolved solids. Soil moisture and potential leachate migration appears to be a spatially variable, localized phenomenon at the landfills.

A program was initiated under the RI to drill seven boreholes into Landfill II through the waste unit to the underlying basalt to determine if leachate is present in or below the landfill. A saturated leachate-bearing layer or perched water body was not encountered during the drilling and sampling of these boreholes, or during the previous (1987) RCRA drilling investigation at Landfills II and III. There is no record of a saturated leachate-bearing layer or perched water body being encountered during any drilling investigation conducted at these landfills at any time.

Weekly toe slope investigations of CFA Landfill II were initiated in June of 1993 and continued through September 1993, and then intermittently through October, November, and December. The investigation involved walking the slope of the landfill to check for moisture and free liquids. At no time was the visible presence of leachate observed anywhere on the landfill or the toe slope of the landfill.

5.3.5 Groundwater

Three rounds of groundwater samples were collected and analyzed from a network of 9 to 10 monitoring wells located both upgradient and downgradient from the CFA landfills and from two production wells used for drinking water at CFA. The samples were analyzed for volatile organic compounds, inorganic compounds, nitrate, sulfate, chloride, fluoride, and alkalinity.

All volatile organic compounds detected during the three phases of sampling are well below maximum contaminant levels (MCLs). No specific source of volatile organic compounds can be identified because concentrations are generally low (near or below instrument detection limits) or detected in both upgradient and downgradient wells. Slight differences in upgradient and downgradient concentrations noted include low concentrations (<1 $\mu g/L$) of trichloroethylene detected in downgradient wells only and chloroform detected in downgradient wells only, but attributed to sample contamination.

Most inorganic compounds detected in the groundwater were below the inorganics' MCL, with the exception of beryllium, cadmium, and lead. Beryllium was detected above the MCL of 4 $\mu g/L$ in groundwater collected from three downgradient wells during Phase I sampling at concentrations ranging from 5.8 to 9.3 $\mu g/L$. However, duplicate samples collected from two of these downgradient wells at the same time were nondetects for beryllium. Beryllium was not detected in groundwater collected from any of the wells during the Phase II sampling. Beryllium was again detected in groundwater collected from one downgradient well during the Phase III sampling at a concentration of 4.6 $\mu g/L$. However, a duplicate sample collected from this same well at the same time was also a nondetect for beryllium. The inconsistency in the data suggest that the beryllium results are possibly false positives or potential anomalies. Some possible explanations for the inconsistent beryllium data include problems with sample collection, preservation, and laboratory analysis, or possible seasonal (spring) influence on groundwater quality. Since the samples are unfiltered, the positive beryllium results may be representative of the original metallic ion content of the silt or clay particles present in the formation and any sorption of ions to the particles from friction-related wear of the pump rather than introduced from a potential waste source, such as the landfills.

Cadmium was detected above the MCL of 5 μg/L in groundwater collected from upgradient wells at concentrations ranging from 8 to 106 μg/L and downgradient wells at concentrations ranging from 5.3 to 17 μg/L during all three phases of sampling. The distribution of cadmium in both upgradient and downgradient wells, coupled with the fact that concentrations of cadmium are not significantly higher in the downgradient wells, suggests that the landfills may not be the source of cadmium in the groundwater. Background concentrations of cadmium in water from the SRPA generally are less than 1 μg/L. Given the uncertainty of the cadmium and beryllium data, these contaminants were identified as potential contaminants of concern and were quantitatively assessed in the human health risk assessment.

Lead was detected above the action level of 15 μg/L in groundwater collected from upgradient well LF 3-11 at a concentration of 56.7 μg/L during the Phase II sampling. Detections of lead in downgradient wells were below the action level. Prior to 1984, approximately 340 lb of lead was disposed to wastewater discharged at ICPP, a facility upgradient of the landfills. The wastewater was discharged to the ICPP injection/disposal well. (The source of this information on lead disposal, as cited in the Remedial Investigation report, is "Orr, B. R. and L. D. Cecil, 1991, Hydrologic Conditions and Distribution of Selected Chemical Constituents in Water, Snake River Plain Aquifer, INEL, Idaho 1986 to 1988, U.S. Geological Survey Water-Resources Investigations Report 91-4047, DOE/ID-22096, p. 44.") Because lead was detected in upgradient wells and not significantly higher in downgradient wells, and a known upgradient source exists, its presence in the groundwater is considered to be unrelated to the CFA landfills.

Nickel was detected above the risk-based screening concentration of 70 μg/L in upgradient well LF2-11 at a concentration of 99 μg/L during Phase II sampling and in downgradient well LF2-12 at a concentration of 117 μg/L during Phase III sampling. However, the filtered sample collected from this downgradient well was a nondetect for nickel, and it was not detected in groundwater collected from this well during the Phase I and II sampling. The inconsistency in the data suggests that the nickel result is possibly a false positive or potential anomaly. For example, particulate nickel may have been introduced into the water pumped from this well due to friction-related wear inside the pump.

Zinc was detected in one upgradient well and one downgradient well at concentrations of 35,500 and 1,380 μg/L, respectively, during Phase II sampling, and in one upgradient and one downgradient well at concentrations of 1,050 and 2,370 μg/L, respectively, during the Phase III sampling. These concentrations are above the risk-based screening concentration of 1,000 μg/L.

The chloride, fluoride, nitrate, and sulfate concentrations during Phase I, II, and III sampling events were all below their respective primary or secondary MCLs and within the range of background concentrations common to the SRPA under the INEL.

5.3.6 Air

Volatile organic compound emission-rate measurements were taken from the surface of all three landfills using a surface flux chamber and sorbent cartridges. Emissions are very low (0.0089 to 1.6 $\mu g/m^2/min$) and similar in terms of type and level of emissions for the locations tested on all three landfills. Methane was not detected in air emanating from the surface of these landfills. Volatile organic compounds measured at Landfill I include acetone, benzene, methylene chloride, 1,1-dichloroethene, 1,1,1-trichloroethane, toluene, tetrachloroethene, and trichloroethene. Volatile organic compounds measured at Landfill II include acetone and dichlorodifluoromethane. Volatile organic compounds measured at Landfill III include acetone, dichlorodifluoromethane, and toluene. The emissions from the landfills are well below risk-based screening levels and do not pose a health hazard to the public or workers.

6. SUMMARY OF SITE RISKS

The human health risk assessment for the CFA landfills evaluated potential adverse health effects associated with exposure to contaminants of concern detected at the landfills under the no-action alternative for both present workers and potential future residents. The risk assessment was conducted in accordance with EPA *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual and Volume II: Environmental Assessment Manual* and other EPA guidance. The risk assessment methods and results are summarized in the following sections. More detailed information may be found in the "Remedial Investigation/Feasibility Study for Operable Unit 4-12: Central Facilities Area Landfills I, II, and III at the Idaho National Engineering Laboratory."

6.1 Human Health Risks

The human health risk assessment consisted of identifying contaminants of potential concern, an exposure assessment, a toxicity assessment, a risk characterization, and an uncertainty analysis. Contaminants of concern were identified based on field investigations, which were conducted to characterize surface soil, groundwater, and air emissions for the landfills, and waste inventory records. The exposure assessment detailed the exposure pathways that exist at the site for current workers and potential future residents. The toxicity assessment documented the adverse health effects to an individual as a result of exposure to a site contaminant. The human health risk assessment evaluated both noncarcinogenic health effects and carcinogenic risks associated with exposure to site contaminants. Although this risk assessment was performed, uncertainties (see Section 6.1.4) in the source term and the inability to fully characterize the landfills were the primary factors in considering remedial action to be taken at these landfills.

6.1.1 Identification of Contaminants of Concern

Chemical contaminant data from field investigations conducted for the CFA landfills surface soil, groundwater, and air emissions were evaluated to determine the most significant site-related contaminants of potential concern for use in the quantitative risk assessment. Contaminants of concern identified in the surface soil from the cover of Landfill I include beryllium, benzo(a)pyrene, and cobalt-60. Contaminants of concern identified in the surface soil from

Landfill II include the PAHs benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. No contaminants of concern were identified in the surface soil from the cover of Landfill III.

Three rounds of groundwater samples were collected from the landfill monitoring wells and two production wells used as a drinking water source at CFA. Beryllium, cadmium, and zinc were identified as contaminants of concern for the groundwater pathway. Future groundwater concerns, as a result of potential future leaching of the source term to the groundwater, were addressed through modeling and indicated no unacceptable groundwater health risk to potential future residents. Therefore, no additional contaminants of concern were included with the groundwater pathway. However, uncertainties exist in the modeling due to limited field data and incomplete source term inventory information.

Volatile organic compound emission rate measurements were taken at the surface of all three landfills. The emissions from CFA Landfills I, II, and III are very low and do not pose a health threat to the public or workers. No contaminants of concern were identified for the air pathway.

6.1.2 Exposure Assessment

The objective of the exposure assessment was to estimate the type and magnitude of exposures to the contaminants of concern identified for the media associated with the CFA landfills. The exposure assessment identified potentially exposed populations and exposure pathways, estimates of exposure concentrations, and estimates of contaminant intakes for exposure pathways.

6.1.2.1 Potentially Exposed Populations. The potentially exposed populations identified include current site workers and potential future residents that may inhabit the site when DOE relinquishes control of the site (approximately 30- and 100-year scenarios).

6.1.2.2 Exposure Pathways. An exposure pathway describes the course a contaminant takes from the source to the exposed individual. The current land use scenario evaluated the exposure of workers to the incidental ingestion of soil from the cover of CFA Landfills I and II, external exposure to cover soil at CFA Landfill I, and ingestion of groundwater pumped from the CFA production wells. The future land use scenario evaluated the exposure of potential future residents to the incidental ingestion of soil from the cover of CFA Landfills I and II, external gamma radiation exposure to cover soil at CFA Landfill I, and ingestion of groundwater pumped from the downgradient monitoring wells and the CFA production wells. Exposure to inhalation of dust was not evaluated because it is not considered a viable pathway due to the depth of the contaminants.

6.1.2.3 Exposure Concentrations. The validated analytical results of soil collected from the cover of CFA Landfill I and II were used to estimate the reasonable maximum exposure (RME), which is the greatest exposure that could reasonably be expected to occur at the site. The RME concentration was determined by the 95% upper confidence limit (UCL) on the arithmetic mean of the measured contaminant concentrations from the CFA Landfill I and II cover soil. Exposure concentrations in groundwater for the current industrial scenario were based on the three phases of 1993 validated water quality data for the CFA production wells, whereas exposure concentrations in groundwater for future residents were based on the three phases of 1993 validated water quality data for the downgradient monitoring wells and the CFA production wells. The RME concentration for workers was determined by the 95% UCL on the arithmetic mean of the measured contaminant concentrations for the CFA production wells. The RME concentration for future residents was determined by the 95% UCL on the arithmetic mean of the measured contaminant concentrations for the downgradient monitoring wells and CFA production wells. The RME factors used in the risk assessment can be found in Table 6-16 of the Remedial Investigation report.

6.1.3 Risk Characterization

The objective of the risk characterization, the final step in the overall risk assessment process, is to integrate the results of the exposure assessment and the toxicity assessment to estimate risk to humans from exposure to site contaminants. The toxicity and exposure assessments are summarized and integrated into quantitative expressions of risk. The carcinogenic effects or probability that an individual will develop cancer over a lifetime of exposure are estimated from projected intakes and chemical-specific dose-response relationships. Noncarcinogenic effects are characterized by comparing projected intakes of substances to toxicity values.

The calculation of health risks from the potential exposure to carcinogenic contaminants involves multiplying the pathway-specific slope factor (SF) for each carcinogen by the estimated chronic intake value. The risk is expressed probabilistically and is compared to the acceptable NCP risk range of 1 in 10,000 to 1 in 1,000,000 (i.e., 1×10^{-4} to 1×10^{-6}). An excess lifetime cancer risk of 1 in 10,000 indicates that an individual has one excess chance in ten thousand of developing cancer over a lifetime of exposure to a site-related contaminant.

The chronic reference dose (RfD) is used to compare toxic effects of noncarcinogenic contaminants. The hazard potential from toxic effects is computed as the ratio of estimated chronic intake to the pathway-specific RfD, and is referred to as the hazard quotient. Hazard quotients less than 1.0 indicate that intake is less than the RfD. The sum of the hazard quotients is equal to the hazard index. The hazard quotient or index should be interpreted as an index of relative health hazard and does not provide a probabilistic expression of risk. A value less than or equal to 1.0 indicates that it is unlikely for even sensitive subpopulations to experience adverse health effects. A value greater than one requires further considerations and risk management decisions.

6.1.3.1 Current Industrial Use. Health risks were calculated for a current industrial scenario where the workers incidentally ingest soil from the cover of CFA Landfills I and II, external gamma radiation exposure to soil at CFA Landfill I, and ingest water from the CFA production wells. As shown in Table 7, the potential risk for incidental ingestion of soil contaminated with benzo(a)pyrene and beryllium is 3×10^{-7} and 1×10^{-6}, respectively. The external gamma radiation exposure of cobalt-60 contaminated soil at CFA Landfill I is 5×10^{-6}. The ingestion of groundwater contaminated with beryllium is 7×10^{-5}. All potential risks are within or below the accepted risk range of 1×10^{-4} to 1×10^{-6}. As shown in Table 7, the hazard quotient for toxic effects from ingesting groundwater contaminated with cadmium and zinc is 0.1 and 0.0008, respectively. These values and the total hazard index are much less than 1.0, indicating that it is unlikely that workers will experience adverse health effects.

Table 7. Summary of potential carcinogenic risks and noncarcinogenic hazard quotients for CFA Landfills I, II, and III.

Exposure pathway	Contaminant of concern	Current worker risk	Future resident risk[b]
Landfill I			
External exposure	Cobalt-60	5×10^{-6}	5×10^{-11}
Soil ingestion	Beryllium	1×10^{-6}	1×10^{-5}
	Benzo(a)pyrene	4×10^{-7}	4×10^{-6}
Groundwater ingestion	Cadmium	0.1[a]	0.4[a]
	Zinc	0.0008[a]	0.04[a]
Landfill II			
Soil ingestion	Benzo(a)pyrene	3×10^{-7}	7×10^{-7} (adult) 2×10^{-6} (child)
Groundwater ingestion	Beryllium	7×10^{-5}	2×10^{-4}
	Cadmium	0.1[a]	0.4[a]
	Zinc	0.0008[a]	0.04[a]
Landfill III			
Groundwater ingestion	Cadmium	0.1[a]	0.4[a]
	Zinc	0.0008[a]	0.04[a]

a. Estimates of noncarcinogenic risks, in the form of hazard quotients, are all less than 1, indicating that it is unlikely even for sensitive subpopulations to experience adverse health effects.

b. The future resident (both 30- and 100-year) RME concentrations were determined by the 95% UCL on the arithmetic mean of the measured contaminant concentrations from the landfill cover soil and the downgradient wells and the CFA production wells.

Note: Even though the risk assessment indicates that the landfills do not currently present an unacceptable risk to human health, a remedial action of containment is warranted at the site due to the uncertainty associated with the waste regarding the types and amounts of potentially hazardous waste disposed.

6.1.3.2 Future Residential Use. Health risks were calculated for a future residential scenario (both 30- and 100-year) where the residents incidentally ingest soil from the cover of CFA Landfills I and II, external gamma radiation exposure to soil at CFA Landfill I, and ingest groundwater pumped from downgradient monitoring wells and CFA production wells. As shown in Table 7, the potential risk for incidental ingestion of soil contaminated with benzo(a)pyrene and beryllium is 2×10^{-6} and 1×10^{-5}, respectively. The external gamma radiation exposure risk of cobalt-60 contaminated soil at CFA Landfill I is 5×10^{-11}. The potential risk for ingestion of groundwater contaminated with beryllium is 2×10^{-4}. All potential future risks are within or below the accepted risk range of 1×10^{-4} to 1×10^{-6} with the exception of the potential future risk of 2×10^{-4} for the ingestion of groundwater contaminated with beryllium. It is important to note that this potential future risk is based on beryllium groundwater results that are considered false positives or potential anomalies and therefore is not considered a driver for action (see note in Table 7). As shown in Table 7, the hazard quotient for toxic effects from ingesting groundwater contaminated with cadmium and zinc is 0.4 and 0.04, respectively. These values and the total hazard index are much less than 1.0, indicating that it is unlikely residents will experience adverse health effects.

6.1.4 Uncertainty

In this risk assessment, methodologies are employed to evaluate the risks to human health from contaminants of concern detected in the groundwater and the soil cover of CFA Landfills I and II. It should be recognized that such risk assessment methodologies represent an inexact science, and their application is associated with uncertainties. Uncertainties arise because of the need to make assumptions and inferences to compensate for the unknowns or lack of data. Table 8 summarizes the major uncertainties in this risk assessment.

Although there are considerable sources of uncertainty in the risk assessment methodology, the consistent adoption of conservative assumptions and parameter values, and adherence to EPA guideline recommendations are considered to have provided reasonable estimates of risk that are currently posed by the site. However, due to the heterogeneous nature of the waste, complete characterization of the landfill contents was and is not expected. Therefore, future use of the landfills that may involve excavation of the landfill subsurface materials could increase risks of exposure to contaminants (via inhalation, ingestion, and dermal contact) for potential future construction workers and residents. Furthermore, uncertainty in the source term (i.e., waste inventory) used in the groundwater modeling contributes to uncertainty in the potential future groundwater health risk.

6.2 Environmental Risk Assessment

This environmental risk assessment is a qualitative appraisal of the potential effects of the CFA landfills on plants and animals other than people and domesticated species. A quantitative environmental assessment is scheduled to be performed as part of the INEL-wide comprehensive RI/FS tentatively scheduled for 1998 and may also be performed as part of the overall WAG 4 comprehensive RI/FS. This assessment is a cursory look at the potential impacts to ecological receptors from present conditions at the CFA landfills. The assessment identifies sensitive nonhuman and nondomesticated species and characterizes potential exposure pathways, including

Table 8. Summary of major uncertainty factors associated with the CFA Landfills baseline risk assessment.

Uncertainty factor	Effect on risk assessment[a]: Potential magnitude for over-estimating risk	Potential magnitude for under-estimating risk	Potential magnitude for over or under-estimating risk
Environmental sampling and analysis			
Sufficient samples may not have been taken to fully characterize the landfills		Med	
Systematic or random errors in the chemical analyses			Low
Representativeness of samples			Low
Field sampling errors			Low
Heterogeneity of sample matrix			Low
Estimating exposure parameter			
Use of EPA RME values	Low		
Exposure of INEL workers	Med		
Exposure of future residents			Med
Toxicity Assessment			
Use of EPA values	Low		
Lack of SFs for some contaminants		Low	

a. Uncertainty factors marked low may affect estimates of risk by less than one order of magnitude; assumptions marked moderate may affect estimates of risk between one and two orders of magnitude; and assumptions marked high may affect estimates of risk by more than two orders of magnitude. The qualitative ratings are based on best professional judgement and do not represent an actual quantitative analysis of uncertainty.

dermal contact with contaminated soil, inhalation of soil dust, and the ingestion of contaminated plants or animals in the study area. The data for this environmental assessment were developed from a review of existing literature. No site-specific field sampling or receptor study was performed for this assessment.

6.2.1 Contaminants of Concern

Contaminants of concern detected in cover soils at CFA Landfills I and II include PAHs such as benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. These contaminants will be discussed from an ecological perspective.

6.2.2 Exposure Assessment

The three principal direct routes of exposure for terrestrial and avian species are ingestion, inhalation, and dermal contact. The major route of exposure to PAHs for ecological receptors at the landfills is likely dermal contact with subsurface contaminated soil. This exposure would be limited to burrowing animals such as Townsend's ground squirrel, deer mouse, and kangaroo rat. Subsequently, the species that use these burrowing animals as a food source, such as coyotes or birds of prey, would also be at risk from ingestion of contaminated food sources. Transport of pronghorn antelope or sage grouse is also possible; however, use of the area by game species is probably minimal due to poor vegetation cover and proximity to areas of human activity. Moreover, the small proportion of landfill acreage in comparison to typical game species total ranges and by the taking of prey outside the area of influence of the landfills would preclude significant bioconcentration in game species. Inhalation of contaminated fine soil particles, also by burrowing animals, may also be important. Another possible exposure route is ingestion of contaminated soil.

6.2.3 Risk Characterization

PAHs, compounds found in asphalt and petroleum distillates, are byproducts of the burning of organic material, and as such, are common in the environment. PAHs identified as contaminants of concern in this study are carcinogens, with a weight-of-evidence class of B2, probable human carcinogen with sufficient evidence of carcinogenicity in animals with inadequate or no evidence in humans. Benzo(a)anthracene produced tumors in mice at the site of application, and chrysene produced malignant tumors of the liver, lung, lymphatic system, and skin in mice. Since most PAHs are carcinogenic to a varying extent, they may present a risk of cancers to burrowing animals who come in contact with or ingest the PAHs.

6.2.4 Conclusions and Limitations

This environmental risk assessment provides a broad overview of possible exposure of the ecosystem to the potential contaminants of concern. The contaminants (PAHs) are limited in distribution; thus, any effect that could be identified would likely be in an individual organism and not a population or community. Moreover, PAHs are typically immobile in soils and are less likely to be transferred through the food chain. These factors, combined with the lack of water, vegetation, and habitat value for wildlife in the area of the CFA landfills, are likely to limit uptake and accumulation of contaminants in the food chain. There are no known endangered or threatened species residing year-round at the INEL (although they may be found visiting the area), and no known critical habitats. In summary, the contaminants in the CFA landfills are not considered to have any significant disruptive effects on animal or plant populations or the local ecosystem.

Limitations to this qualitative ecological assessment include lack of site-specific information on the exposure frequency, duration, and routes of exposure for terrestrial species to potential contaminants of concern. Also, without adequate toxicity data, the ecological risk of PAHs in the CFA landfills cannot be quantitatively determined.

7. DESCRIPTION OF ALTERNATIVES

The remedial investigation of OU 4-12 indicated that the overall risk associated with the landfills is within the generally acceptable limits of CERCLA; however, due to the uncertainty associated with the landfill contents with regard to the types and amounts of potentially hazardous waste disposed and the need for containment of the landfill contents, a remedial action of containment is warranted for the site. Remedial action of containment is consistent with EPA's presumptive remedy guidance for CERCLA municipal landfills. As such, remedial action alternatives were developed and analyzed in detail for the CFA landfills. Prior to developing alternatives, remedial action objectives (RAOs) were established. These objectives and descriptions of developed alternatives are included in the following sections.

7.1 Remedial Action Objectives

The intent of the RAOs is to set goals for protection of human health and the environment that are consistent with EPA's presumptive remedy guidance. The goals for the CFA landfills are designed specifically to lessen the potential threat (i.e., maintain risk factors within acceptable limits) to human health and the environment posed by direct contact with and migration of contaminants disposed at the CFA landfills. The attainability of RAOs is addressed through the detailed evaluation of overall protectiveness afforded by each remedial action alternative.

In order to identify appropriate RAOs, risks associated with the landfills had to be evaluated. As indicated by the risk assessment presented in Section 6, the present risk associated with the CFA landfills is within the generally acceptable limits of CERCLA (i.e., the landfills do not pose a significant threat to human health and the environment), and the risk as quantified does not warrant an action at the CFA landfills. However, as is typical for landfills, there is a level of uncertainty in characterizing potential future risk, particularly related to the potential for contaminant migration via leachate generation and cover erosion. As such, the RAOs derived for the landfills focus on reducing concerns about potential risk that could not clearly be evaluated as part of the investigation of the landfills. The RAOs include:

- Prevent direct contact with the landfill contents.
- Minimize the potential for erosion and infiltration at the surface.

- Ensure that drinking water standards are not exceeded in the SRPA due to the migration of contaminants from the landfills.

These RAOs were developed to prevent future unacceptable risk from exposure to landfill contaminants, rather than to address any existing unacceptable risk. Adherence to these RAOs is consistent with a presumptive remedy approach that is typical for CERCLA municipal landfills.

7.2 Summary of Alternatives

In accordance with Section 121 of CERCLA, the Feasibility Study (FS) identified and evaluated alternatives in terms of achieving the stated RAOs. The alternatives evaluated in the FS for the CFA landfills were:

- Alternative 1 - No Action with Monitoring.
- Alternative 2 - Institutional Controls with Monitoring.
- Alternative 3 - Uniform Containment with Native Soil Cover, Institutional Controls, and Monitoring.
- Alternative 4 - Containment with Single-Barrier Cover, Institutional Controls, and Monitoring.

The remedial action alternatives were developed by combining process options evaluated in the FS in a manner that focused alternatives on institutional controls and components of a CERCLA municipal landfill presumptive remedy. The No Action alternative was developed to provide a baseline against which other alternatives could be compared.

Substantive Federal and state action-specific applicable or relevant and appropriate requirements (ARARs) have been identified for the alternatives. These ARARs and significant to-be-considered (TBC) criteria are listed in Table 9. The primary ARAR relates to landfill closure under RCRA, as implemented by the State of Idaho under the Idaho Hazardous Waste Management Act (hereinafter, this Idaho statute will be referred to as RCRA). These RCRA requirements were determined to be relevant and appropriate, rather than applicable, because there is no conclusive evidence that RCRA-hazardous waste was disposed to the landfills after the promulgation of the RCRA Subtitle C requirements for hazardous waste. Consideration of the RCRA requirements as relevant and appropriate allows for a combination of requirements for landfill closure. The agencies have determined that, based on characteristics of the CFA landfills and potential remedial action alternatives, "hybrid" landfill closure procedures in CERCLA are suitable.

The substantive RCRA requirements identified as ARARs focus on cover design and include the following primary objectives:

- Provide long-term minimization of migration of liquids.
- Function with minimum maintenance.

Table 9. Summary of ARARs and TBC criteria for CFA landfill alternatives.

Statute	Regulation or Title	Alternative 1 No Action	Alternative 2 Institutional Controls	Alternative 3 Containment with Native Soil Cover	Alternative 4 Containment with Single Barrier Cover
Idaho Hazardous Waste Management Act, 1983 and as amended	Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities, IDAPA § 16.01.05.008 "Landfills, Closure and Post-Closure Care" (derived from 40 CFR 264.310)	R/No	R/No	R/Yes	R/Yes
Idaho Environmental Protection and Health Act, 1972 and as amended	Rules for the Control of Fugitive Dust and General Rules, IDAPA Sections 16.01.01.650 and .01.651	Not ARAR	Not ARAR	A/Yes	A/Yes
	Presumptive Remedy for CERCLA Municipal Landfill Sites, OSWER Directive 9355.0-49	TBC	TBC	TBC	TBC
	RCRA ARARs: Focus on Closure Requirements, OSWER Directive 9234.2-04FS	TBC	TBC	TBC	TBC
	Evaluating Cover Systems for Solid and Hazardous Waste (Revised), OSWER Directive 9476.00-1	TBC	TBC	TBC	TBC

Yes/No = meets or does not meet ARARs.
A = applicable.
R = relevant and appropriate.
TBC = to be considered.

- Promote drainage and minimize erosion.

- Accommodate settling and subsidence.

- Provide a hydraulic conductivity less than or equal to any bottom liner system or natural subsoils present.

In addition, RCRA monitoring requirements deemed by the agencies to be appropriate during remedial design will be met.

There were no chemical-specific ARARs identified for the considered alternatives. Regulations have not been promulgated specific to soil cleanup levels for contaminants that may be present in soils at the CFA landfills. Also, no location-specific ARARs were identified as there are no known threatened and endangered species, wetlands, rivers, or floodplains located in the area of potential remedial activities under the considered alternatives. Areas that may be impacted by the considered alternatives include soil borrow areas. Borrow areas at the INEL have been evaluated through an environmental assessment, which determined that these areas do not impact historical and cultural properties, nor do they impact archeological resources.

7.3 Alternative 1 - No Action with Monitoring

Consideration of the No Action alternative is required by the NCP [40 CFR 300.430(e)(6)] as a baseline against which other alternatives are compared. Under this alternative, no attempt would be made to contain the contents of the CFA landfills. The only action taken under this alternative would be groundwater monitoring. The agencies would review this action, including the need for continued monitoring and the frequency and scope thereof, within 5 years and every 5 years thereafter. A monitoring plan, developed by the agencies, would define the wells that would be monitored, parameters to be monitored, frequency of monitoring, and reporting requirements. Access to the site and possible exposure to site surface soils would not be prevented under this alternative beyond the period during which DOE maintains control of the landfill area (assumed to be 30 years).

Alternative 1 would not meet the substantive relevant and appropriate requirements of RCRA, as implemented by the State of Idaho, identified in Table 9. These requirements focus on cover design and are summarized in Section 7.2. Alternative 1 would not meet the requirement that the cover promote drainage and minimize erosion as it does not include measures to provide for even runoff of precipitation. Net present value costs for implementing groundwater monitoring (30 years assumed) under this alternative are estimated to be $968,000.

7.4 Alternative 2 - Institutional Controls with Monitoring

In addition to groundwater monitoring as described for Alternative 1, this alternative would consist of infiltration monitoring and institutional controls including fencing, which would be implemented after DOE's institutional control period (assumed to be 30 years) to prevent access to the site and future disturbance of the site soils. Potentially, enforcement of institutional controls may be by a party other than the DOE. Alternative 2 takes no steps to minimize the potential for contaminant migration. Actual monitoring locations and frequency would be identified in a monitoring plan that would be developed as part of the design for this alternative. The need for continued infiltration monitoring would be reviewed along with the groundwater monitoring review as described for Alternative 1. For cost estimating purposes, it was assumed that neutron probe and lysimeter probe analyses would be performed monthly and semiannually, respectively, at 18 locations within the landfills. Five of the neutron probe boreholes already exist.

Alternative 2 would not meet the substantive relevant and appropriate requirements of RCRA, as implemented by the State of Idaho, identified in Table 9. These requirements focus on cover design and are summarized in Section 7.2. Alternative 2 would not meet the requirement that the cover promotes drainage and minimizes erosion as it does not include measures to provide for even runoff of precipitation. Net present value costs for implementing groundwater and infiltration monitoring (30 years assumed) and installing a fence around the landfills at the end of DOE's control of the site are estimated to be $1,940,000.

7.5 Alternative 3 - Uniform Containment with Native Soil Cover, Institutional Controls, and Monitoring

This alternative would ensure a minimum thickness of at least 2 ft of clean, compactable, native (i.e., found at or near the INEL) soils cover the entire surface area of the CFA landfills. This cover of native soil would prevent surface exposure to contaminants in the landfill areas. The cover would also be constructed to prevent migration of contaminants through dust emissions or runoff erosion and reduce infiltration and the potential for contaminant migration. The soil layer would be graded to allow efficient rainwater runoff, and natural vegetation would be planted to stabilize the soil surface and promote evapotranspiration. Existing soil cover material would be incorporated in the minimum 2-ft final cover thickness. It is expected that up to 55,000 yd^3 of native soil would have to be brought to the landfills from a source at the site in order to accomplish the appropriate grading and cover thickness. Grading activities would include measures to minimize dust generation. The volume of 55,000 yd^3 is an estimate based on data available from the remedial investigation. Also, the thickness of two feet is considered to provide an appropriate level of protection in conjunction with institutional controls against direct exposure at this site and is considered a typical native soil cover thickness for CERCLA municipal landfills (Design and Construction of RCRA/CERCLA Final Covers, EPA/625/4-91/025). This type of cover would not include an impermeable layer over the landfill contents; therefore, the accumulation of landfill gas is not likely to be a concern.

Administrative controls such as placing written notification of this remedial action in the facility land use master plan would also be required to ensure that potential future activities would not compromise the integrity of the cover. A copy of the notification would be given to the Bureau of Land Management (BLM) together with a request that a similar notification be placed in the BLM's property management records for this site. Borders would be delineated through the posting of signs warning of the landfills' existence and potentially contaminated soils.

Groundwater monitoring as described for Alternative 1 would be implemented under Alternative 3 after the placement of the native soil cover. Alternative 3 would also include measures to monitor infiltration as described for Alternative 2. Routine maintenance of the cover would continue as needed. The agencies will review this action, including the need for continued monitoring and the frequency and scope thereof, within 5 years and every 5 years thereafter.

Alternative 3 would meet the substantive relevant and appropriate requirements of RCRA, as implemented by the State of Idaho, identified in Table 9. These requirements focus on cover design and are summarized in Section 7.2. This alternative would also meet the requirements for control of fugitive dust through engineered methods to minimize dust generation. Net present value costs for implementing all of the elements described above are estimated to be $3,500,000, which assumes a 30-year groundwater and infiltration monitoring period.

7.6 Alternative 4 - Containment with Single-Barrier Cover, Institutional Controls, and Monitoring

This alternative involves placing a single-barrier cover over the entire surface area of each of the CFA landfills. The cover would be constructed of either 2 ft of impermeable clay or a geomembrane layer (for purposes of evaluation, it was assumed that a clay layer would be used with the clay being a mixture of imported bentonite and native local soils). Two feet of clay is standard for impermeable covers at landfills (Design and Construction of RCRA/CERCLA Final Covers, EPA/625/4-91/025). The 2-ft thickness is necessary to maintain the clay layer's integrity over the long term. Prior to placement of the clay layer, the landfill area would be surveyed to ensure a minimum of 12 in. of compacted native soil bedding layer was in place. Thirty inches of native soil would be placed on top of the clay and the area revegetated with indigenous species. This impermeable type of cover would prevent surface exposure to contaminants in the landfill areas as well as greatly reduce water infiltration through the landfill contents. As with the native soil cover described for Alternative 3, this cover would prevent migration of contaminants via dust emissions or runoff erosion. The top native soil layer would be graded to allow efficient rainwater runoff. Grading activities would include measures to minimize dust generation. The total amount of bentonite that would be required is approximately 20,000 tons (based on a 10% blend with native soils), while the total amount of native soil required would be approximately 350,000 tons (approximately 260,000 yd^3).

It is common practice to manufacture a clayey material by blending local soils with imported bentonite when local clay soils are not available. In general, silt and silty sand soils with few gravel or cobble-sized particles are used in blending a clay cover. Poorly graded, sandy soils with abundant oversized particles are generally unsuitable for blending. Granular bentonite is typically imported by rail or truck from quarries in Wyoming.

Selected local soils can be mixed with approximately 10% granular bentonite and sufficient water to allow compaction. The specific proportions to be used at the CFA landfills would require determination by a laboratory testing program after the native soil site is identified. Blending can be achieved at the site with a pugmill or other specialized mixing equipment. The material would then be placed on a prepared subgrade and compacted with a sheepsfoot compactor or other equipment capable of providing "kneading" compaction.

Administrative controls and posting of signs would be included with this alternative as described for Alternative 3; groundwater monitoring would be implemented as described for Alternative 1; and infiltration monitoring would be implemented as described for Alternative 2. Soil vapor monitoring would also be a component of this alternative. Because the cover would include an impermeable layer over the landfill contents, landfill gas could potentially accumulate to unsafe levels. Soil vapor monitoring would provide early indication of such an accumulation of gas. This monitoring could be ceased over time if the landfill gas levels remain low. It was assumed that soil vapor monitoring would continue for 30 years after cap installation at five passive vents located at each landfill; however, the need for the soil vapor monitoring would be reviewed every 5 years. If gas was to accumulate to unsafe levels, then additional vents could be installed. Routine cover maintenance would continue as necessary. The agencies will review this action, including the need for continued monitoring and the frequency and scope thereof, within 5 years and every 5 years thereafter.

Alternative 4 would meet the substantive relevant and appropriate requirements of RCRA, as implemented by the State of Idaho, identified in Table 9. These requirements focus on cover design and are summarized in Section 7.2. This alternative would also meet the requirements for control of fugitive dust through engineered methods to minimize dust generation. Net present value costs for implementing all of the elements described above are estimated to be $15,200,000, which assumes 30 years of groundwater, infiltration, and soil vapor monitoring.

8. SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

CERCLA guidance requires that each remedial alternative be compared according to nine evaluation criteria that have been developed to serve as a basis for conducting the detailed analyses of alternatives and selecting an appropriate remedial action. The evaluation criteria are divided into three categories: (1) threshold criteria that relate directly to statutory findings and must be satisfied by each chosen alternative, (2) primary balancing criteria that include long- and short-term effectiveness, implementability, reduction of toxicity, mobility, and volume, and cost, and (3) modifying criteria that measure the acceptability of the alternatives to state agencies and the community. The following sections summarize the evaluation of the candidate remedial alternatives according to these criteria.

8.1 Threshold Criteria

The remedial alternatives were evaluated in relation to the threshold criteria: overall protection of human health and the environment and compliance with ARARs.

8.1.1 Overall Protection of Human Health and the Environment

This criterion addresses whether an alternative provides protection of human health and the environment and includes an assessment of how risks posed through each exposure pathway are eliminated, reduced, or controlled through treatment, engineering controls, or institutional controls. As noted in Section 7.1, the remedial investigation of OU 4-12 indicated that the current risk associated with the landfills is within the generally acceptable limits of CERCLA;

however, there is a significant level of uncertainty in characterizing the landfill contents. Thus, an effort to reduce the potential for future unacceptable risks is the focus of RAOs for the landfills.

Alternatives 3 and 4 achieve the RAOs identified in Section 7.1, thus satisfying the criterion of overall protection of human health and the environment. The alternatives accomplish this by eliminating the direct exposure pathways (i.e., contact with landfill waste and/or contaminated soils) and reducing the potential for contaminant migration via mechanisms such as erosion at the surface and infiltration. Through institutional controls, Alternative 2 achieves the RAO to eliminate direct exposure pathways. However, Alternative 2 does not include measures to reduce the potential for contaminant migration at the surface or to the SRPA. Alternative 1, No Action, does not achieve the RAOs.

Overall, Alternatives 3 and 4 would significantly reduce the potential for unacceptable risk at the CFA landfills. As such, the residual risk associated with Alternatives 3 and 4 is believed to be acceptable (i.e., fall within or below the acceptable risk range of 10^{-4} to 10^{-6}). Under Alternative 2, there is a potential that unacceptable risk would remain because Alternative 2 takes no action to minimize contaminant migration; however, Alternative 2 does include measures to eliminate direct exposure pathways. Alternative 1, No Action, takes no steps to prevent erosion at the surface and possible subsequent infiltration, nor does it eliminate direct exposure pathways. Therefore, it does not reduce the potential for future unacceptable risks that may occur. Thus, Alternative 1 is not considered to be protective of human health and the environment.

8.1.2 Compliance with ARARs

CERCLA, as amended by SARA, requires that remedial actions for Superfund sites comply with identified substantive applicable requirements identified under Federal and state laws. Remedial actions must also comply with the substantive requirements of laws and regulations that are not directly applicable but are relevant and appropriate, in other words, requirements that pertain to situations sufficiently similar to those encountered at a Superfund site so that their use is well suited to the site. Combined, these are referred to as applicable or relevant and appropriate requirements or ARARs. State ARARs are limited to those requirements that are (1) promulgated, (2) uniformly applied, and (3) are more stringent than Federal requirements. Compliance with ARARs requires evaluation of the remedial alternatives for compliance with chemical-, action-, and location-specific requirements.

Alternatives 3 and 4 meet all of the substantive relevant and appropriate requirements of RCRA identified in Table 9. The requirements considered relevant and appropriate are action-specific focusing on cover design and include the following primary objectives:

- Provide long-term minimization of migration of liquids.
- Function with minimum maintenance.
- Promote drainage and minimize erosion.
- Accommodate settling and subsidence.

- Provide a hydraulic conductivity less than or equal to any bottom liner system or natural subsoils present.

Alternatives 1 and 2 do not meet the substantive relevant and appropriate requirements identified under RCRA as neither of these alternatives provide a cover designed to promote drainage and minimize infiltration. Alternatives 3 and 4 would meet applicable fugitive dust requirements through engineered controls.

8.2 Balancing Criteria

The balancing criteria are used in refining the selection of the candidate alternatives for the site. The five balancing criteria are (1) long-term effectiveness and permanence, (2) reduction of toxicity, mobility, or volume through treatment, (3) short-term effectiveness, (4) implementability, and (5) cost. Each criterion is further explained in the following sections.

8.2.1 Long-Term Effectiveness and Permanence

This criterion evaluates the long-term effectiveness of alternatives in maintaining protection of human health and the environment.

Alternative 4 would provide the greatest level of long-term effectiveness and permanence because of its engineered cover that includes a clay layer. The single-barrier cover developed under Alternative 4 would minimize the potential for direct exposure to the landfill contents and the potential for contaminant migration over a longer period of time than the other alternatives considered. Alternative 3 would provide greater long-term effectiveness and permanence than Alternative 2. The grading and placement of native soil as a cover under Alternative 3 would increase the long-term effectiveness and permanence beyond that afforded by institutional controls only. Alternative 1, No Action, would provide the lowest level of long-term effectiveness and permanence relative to the other alternatives.

8.2.2 Reduction of Toxicity, Mobility, or Volume through Treatment

None of the alternatives afford any reduction of toxicity, mobility, or volume through treatment as no elements of treatment are included in any of the alternatives.

8.2.3 Short-Term Effectiveness

In general, the alternatives requiring the least amount of on-site worker activity (e.g., construction) would provide the greatest degree of short-term effectiveness because they pose the least amount of risk to site personnel and the public during remediation activities. On this basis, since the landfills in their current condition pose no immediate threat to human health or the environment, Alternative 1, No Action, ranks the highest of the alternatives considered. Alternative 4 includes activities that pose the most significant risk to worker and public health during implementation (e.g., trucking operations to transport clay materials to the INEL). Activities associated with Alternative 3 would pose less risk to worker and public health than Alternative 4 but more risk than Alternative 2.

8.2.4 Implementability

Each of the alternatives considered is implementable. Alternative 1, No Action, is the most readily implementable as it would require no activities other than groundwater monitoring (an element of each of the developed alternatives). Alternative 4 is the least implementable because it has the most complex construction requirements, and materials needed for the clay layer must be obtained from off-site resources. Alternative 3 is more readily implementable than Alternative 4 but less implementable than Alternative 2.

8.2.5 Cost

In evaluating project costs, an estimation of the net present value of capital costs and post-closure costs is required. In accordance with CERCLA guidance (Superfund Decision Document, EPA, 1992), the costs presented are estimates (i.e., -30% to +50%). Actual costs could vary based on the final design and detailed cost itemization. The cost estimates for the alternatives analyzed for the CFA landfills are presented in Table 10. Capital costs include materials and construction; post-closure costs include monitoring. While Alternative 4 slightly increases overall protection of human health and the environment, Alternative 3 achieves the RAOs at a significantly lower cost.

8.3 Modifying Criteria

The modifying criteria are used in the final evaluation of remedial alternatives. The two modifying criteria are state and community acceptance. For both of these criteria, the factors that are considered include the elements of the alternatives that are supported, the elements of the alternatives that are not supported, and the elements of the alternatives that have strong opposition.

8.3.1 State Acceptance

The IDHW concurs with the selected remedial alternative, Containment with a Native Soil Cover, Institutional Controls, and Monitoring. The IDHW has been involved in the development and review of the RI/FS report, the Proposed Plan, this ROD, and other project activities such as public meetings.

8.3.2 Community Acceptance

This assessment evaluates the general community response to the proposed alternatives presented in the Proposed Plan. Specific comments received during the public comment period on the Proposed Plan are responded to in the attached Responsiveness Summary portion of this document. Generally, comments reflected a broad range of views, from strong support for the selected alternative to opposition and support for the No Action alternative.

Table 10. CFA landfills alternative cost estimates[a] (net present value).

Cost element	Alternative 1 (no action)	Alternative 2	Alternative 3	Alternative 4
Capital	$338,785	$521,711	$2,016,821	$11,918,186
Post-closure	$628,898	$1,418,545	$1,484,290	$3,293,898
Total (rounded)	$968,000	$1,940,000	$3,500,000	$15,212,000

a. Cost estimates assume 30 years of monitoring and maintenance. Relatively intensive monitoring is anticipated in the first few years in order to establish the baseline data. Because it is not known precisely what level of monitoring will be needed after the first few years, the cost estimate assumes that the intensive monitoring continues for the entire 30 years. The actual monitoring costs are expected to be lower than estimated. The estimates also assume installation of one additional groundwater monitoring well ($215,000), the need for this well will be determined during the remedial design phase.

9. SELECTED REMEDY

Based upon consideration of the requirements of CERCLA, the detailed analysis of alternatives, and public comments, DOE, EPA, and IDHW have selected Alternative 3 - Uniform Containment with Native Soil Cover, Institutional Controls, and Monitoring as the most appropriate remedy for the OU 4-12 CFA landfills. Containment with a native soil cover is believed to be the best alternative for minimizing public risk and providing long-term protection of the SRPA.

9.1 Uniform Containment with Native Soil Cover - Description

The major components of Alternative 3 - Uniform Containment with Native Soil Cover, Institutional Controls, and Monitoring include (1) the placement of a uniform native soil cover over Landfills I, II, and III, (2) the implementation of institutional controls, and (3) the periodic monitoring of groundwater, infiltration, and/or vadose zone. The selected alternative is believed to provide the best balance of trade-offs among the alternatives with respect to the nine CERCLA evaluation criteria. DOE, EPA, and IDHW believe the preferred alternative is protective of human health and the environment, complies with ARARs, and is the most cost-effective of the alternatives evaluated.

Alternative 3 ensures that a thickness of at least 2 ft of a combination of existing soil cover and clean, compacted, native soils cover the landfills' waste. Overall design criteria for the cover will be specified by the agencies in the RD/RA work plan. These criteria will include requirements for hydraulic conductivity, as-built cover thickness and tolerances, erosion control, and revegetation. The permeability of cover soils at Landfills II and III are 2×10^{-3} cm/sec and 2×10^{-5} cm/sec, respectively, as shown in Table 3-11 of the RI/FS. No information is currently available for the permeability of cover soils at Landfill I as no investigation pertaining to this parameter was made during the Track 2 investigation. The existing landfills will be surveyed and measures will be taken to provide a cover that is graded to promote efficient runoff and eliminate "low spots" where precipitation could accumulate and potentially infiltrate into the landfill contents. Routine maintenance of the cover will include placement of soils as needed to eliminate low spots that may form due to landfill content subsidence. Long-term stability of the cover will be enhanced by promoting the growth of natural vegetation at the cover's surface. The cover will be installed using conventional earth moving equipment and measures will be taken to minimize dust generation. The existing soils covering the CFA landfills will be supplemented as necessary with native soils from a borrow site located in the southwestern portion of the INEL. These borrow site soils have been examined and meet the permeability requirements for use as landfill cover material. It is expected that approximately 55,000 yd^3 of native soil will be brought to the landfills.

In addition to the placement of a native soil cover, Alternative 3 will include institutional controls. These institutional controls will include administrative controls such as placing written notification of this remedial action in the facility land use master plan to ensure that potential future activities would not compromise the integrity of the cover. A copy of the notification will be given to the BLM together with a request that a similar notification be placed in the BLM's property management records for this site. Borders will be delineated through the posting of signs warning of the landfill existence and potentially contaminated soils.

Groundwater, infiltration, and/or vadose zone monitoring will be conducted under Alternative 3. Groundwater monitoring would be conducted in order to (1) establish a baseline of potential contaminant concentrations in the aquifer against which future data could be compared, and (2) ensure that drinking water standards are not exceeded in the SRPA due to the migration of contaminants from the landfills. Infiltration and/or vadose zone monitoring would be conducted in order to evaluate the effectiveness of the native soil cover and/or migration of potential contaminants from the landfills.

The agencies will review this action, including the need for continued monitoring and the frequency and scope thereof, within 5 years and every 5 years thereafter.

9.2 Estimated Costs for the Selected Remedy

A summary cost breakdown for Alternative 3 is presented in Table 10. These costs were annualized where appropriate (e.g., monitoring costs) and summarized in net present value (1994) using a 5% annual discount rate.

10. STATUTORY DETERMINATIONS

Remedy selection is based on CERCLA, as amended by SARA, and the regulations contained in the NCP. All remedies must meet the threshold criteria established in the NCP: protection of human health and the environment and compliance with ARARs. CERCLA also requires that the remedy use permanent solutions and alternative treatment technologies to the maximum extent practicable, and that the implemented action must be cost-effective. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduce the volume, toxicity, or mobility of hazardous wastes as their principal element. The following sections discuss how the selected remedy meets these statutory requirements.

10.1 Protection of Human Health and the Environment

As described in Section 8.1.1, the selected remedy satisfies the criterion of overall protection of human health and the environment by minimizing the risk of potential contaminant migration and by preventing direct contact with the landfill waste materials. The remedy will ensure that cumulative risks are maintained within or below the acceptable risk range of 10^{-4} to 10^{-6}.

10.2 Compliance with ARARs

The selected remedy will be designed to meet all ARARs of Federal and state regulations. The ARARs that will be achieved by the selected remedy are noted in Section 7.2, particularly Table 9.

10.2.1 Chemical-Specific ARARs

There were no chemical-specific ARARs identified for the CFA landfills. Regulations have not been promulgated specific to soil cleanup levels for contaminants that may be present in soils at the CFA landfills.

10.2.2 Action-Specific ARARs

The selected remedy triggers the applicable or relevant and appropriate requirements of those regulations listed in Table 9. As noted in Section 7.2, these ARARs focus primarily on landfill closure under RCRA as implemented by the State of Idaho under the Idaho Hazardous Waste Management Act. Additionally, Rules for the Control of Fugitive Dust and General Rules under IDAPA 16.01.01.650 and .01.651 apply to the selected remedy.

10.2.3 Location-Specific ARARs

There were no location-specific ARARs identified for the selected remedy as there are no known threatened and endangered species, wetlands, rivers, or floodplains located in the area of potential remedial activities under the selected remedy. This includes those areas identified as soil borrow areas at the INEL. Borrow areas at the INEL have been evaluated through an environmental assessment, which determined that these areas do not impact historical and cultural properties, nor do they impact archeological resources.

10.2.4 To-be-Considered Guidance

In implementing the selected remedy, the agencies have agreed to consider a number of procedures or guidance documents that are not legally binding. The following list of documents are to be considered as guidance documents:

- OSWER 9355.0-49FS, September 1993, *Presumptive Remedy for CERCLA Municipal Landfill Sites.*

- OSWER 9234.2-04FS, October 1989, *RCRA ARARs: Focus on Closure Requirements.*

- OSWER 9476.00-1, September 1982, *Evaluating Cover Systems for Solid and Hazardous Waste* (Revised).

These OSWER directives provide additional guidance on the design specifications for constructing and maintaining a cover system.

10.3 Cost-Effectiveness

Based on expected performance, the selected remedy is considered to be cost-effective. This is evident when considering the cost of Alternative 4, Containment with a Single-Barrier Cover, which is estimated to be over four times the estimated cost of the selected remedy, yet it is believed that Alternative 4 would not provide significant additional benefits in terms of protectiveness.

10.4 Use of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost-effective manner. The selected remedy provides protection by minimizing the risk of contaminant migration to the aquifer and limiting access to the landfill contents. The selected remedy for the CFA landfills contains elements of EPA's presumptive remedy for CERCLA municipal landfills. The presumptive remedy is based on historical patterns of remedy selection and scientific and engineering evaluation of performance data on technology implementation at similar sites.

Implementation of the selected cover remedy will reduce the mobility of hazardous substances, pollutants, and contaminants from the CFA landfills. The selected remedy does not employ alternative treatment or resource recovery technologies. The use of alternative treatment technologies was determined to be impracticable because no on-site hot spots were identified that could be excavated and treated effectively, and because the wastes can be reliably controlled in place.

10.5 Preference for Treatment as a Principal Element

The statutory preference for remedies that employ treatment as a principal element will not be met. Extraction and treatment of the landfill contents is not considered a cost-effective means of reducing the risks to human health and the environment. The identified risks will be reduced to acceptable levels by implementing the selected remedy. The remedy, which includes containment, monitoring, and land use controls, is based on experience from remedies implemented at other CERCLA municipal landfills and is consistent with EPA's presumptive remedy.

11. NO ACTION SITES IN OPERABLE UNIT 4-03

This section of the ROD summarizes information on 19 Track 1 investigations (consisting of underground storage tank sites) designated as "no further action" and documents the "no further action" decision for these sites. These sites were identified in the FFA/CO for the Track 1 investigation process because they were considered low probability hazard sites and are included in OU 4-03. Low probability hazard sites typically contain low or unknown quantities of residual contamination. The 19 sites discussed in further detail below were identified by DOE, EPA, and IDHW as posing no unacceptable risk to human health.

In accordance with the FFA/CO, the Track 1 process evaluates existing data and information on the Track 1 site to determine whether the site poses an unacceptable risk to human health. The information is assembled into a decision documentation package involving questions about possible past containment releases and qualitative risk evaluation. The Track 1 approach is an efficient yet rigorous process to evaluate risks. The evaluation process is used to determine if (a) the site poses a clear risk that requires interim action, (b) the site should be further investigated under CERCLA, or (c) the source does not appear to pose a risk to human health or the environment and therefore requires no further action.

Except where noted, all of the tanks, their contents, and associated piping were removed. All of the tank sites were backfilled with soil and restored for unrestricted use. In many cases, the tank and associated piping were recycled as scrap metal. Several of the tank sites had petroleum-related organic contamination in the soil in the bottom of the excavation. In each case, a risk evaluation determined that the soil concentration for these contaminants did not exceed the 1 in 1,000,000 risk-based concentrations for inhalation of volatile organic compounds and dust, ingestion of soil, and ingestion of groundwater. A short discussion of each of the 19 underground storage tank sites follows.

CFA-18, Fire Department Training Area Gasoline Storage Tank. This is a 500-gal gasoline tank installed in 1952, which is still in use (and is thus subject to appropriate rules and regulations for ongoing operations). No leakage was observed from the tank during tightness testing performed in March 1993. Also, no contaminants have been observed near the tank. Based on this investigation of potential past releases from the tank, no further action is recommended.

CFA-19, Fuel Tanks at CFA-606. This is the site of two former 10,000-gal fuel tanks installed in 1948 and last used in 1950. Tanks CFA 606-E1 and -E2 were used to store gasoline and diesel fuel, respectively, for unknown purposes. All attempts to locate the tanks and associated piping (with ground-penetrating radar and metal detector) were unsuccessful, and there was no visible evidence of excavated areas or piping to the tanks. It is believed that the tanks have been removed and the areas have been backfilled. According to records, no tank content or soil samples were collected at this site because the tanks were not located.

CFA-20, Fuel Oil Tank at former CFA-609 (near current CFA-612). This is the site of a former 275-gal fuel tank installed in 1952 and last used in 1985. The tank was used to store fuel oil for heating building CFA-609, which was demolished and replaced by the current CFA-612 and an adjacent asphalt parking lot. Although no written record of removal was found, there was reference to a letter stating that the tank had been excavated. Also, an equipment operator who worked on demolition of the old CFA-609 indicated that the tank had been removed and the excavation backfilled about 1985 or 1986. No efforts could be made in the field to locate the original tank site because the tank site has been covered with a parking lot and a building. No tank content sampling or soil sampling records could be found.

CFA-21, Fuel Tank at Nevada Circle 1 (South by CFA-629). This is a former 500-gal gasoline tank installed in 1958 and last used in 1970. The tank and associated piping were excavated and removed from the ground in May 1991. During removal operations, the tank was inadvertently punctured by excavation equipment resulting in a spill of approximately 75 gal of diesel fuel in the excavation. Contaminated soil was removed from the excavation and treated. Approximately 60 gal of spilled fuel was retrieved and 15 gal absorbed into soil resulting in high concentrations of total petroleum hydrocarbons in two soil samples (20,000 and 54,000 mg/kg). However, because the volume of spilled fuel is low and total petroleum hydrocarbons are relatively immobile in the soil, further sampling was not conducted. All other contaminants detected in the excavation beneath the tank were below the 1 in 1,000,000 risk-based concentrations.

CFA-23, Fuel Oil Tank at CFA-641. This is a former 55-gal fuel oil tank installed in 1949 and last used in 1975. The tank and associated piping were excavated and removed from the ground in October 1990. No holes in the tank or piping or other evidence of leakage were observed during removal operations. No contaminants were detected at levels that exceed the 1 in 1,000,000 risk-based concentrations.

CFA-24, Heating Fuel Tank near CFA-629. This is a former 500-gal heating fuel tank installed in 1958 and last used in 1970. The tank (no associated piping was found) was excavated and removed from the ground in May 1991. No holes in the tank or other evidence of leakage was observed during removal operations. No contaminants were detected at levels that exceed the 1 in 1,000,000 risk-based concentrations.

CFA-25, Fuel Oil Tank at CFA-656. This is a former 500-gal fuel oil tank installed in 1944 and last used in 1960. The tank and associated piping were excavated and removed from the ground in October 1990. No evidence of leakage was observed from the tank or associated piping during removal operations. No contaminants were detected in the excavation beneath the tank above the 1 in 1,000,000 risk-based concentrations.

CFA-27, Fuel Oil Tank at CFA-669 (CFA-740). This is a former 15,000-gal fuel oil tank installed in 1953 and last used in 1981. The tank and associated piping were excavated and removed from the ground in October 1990. Evidence of leakage from the piping was observed during removal operations; however, there was no evidence of leakage from the tank. Contaminated soil was removed and treated. No contaminants were detected in the excavation beneath the former tank or piping above the 1 in 1,000,000 risk-based concentrations.

CFA-28, Fuel Oil Tank at CFA-674 (West). This is a former 1,000-gal fuel oil tank installed in 1956 and last used in 1968. The tank was excavated and removed from the ground in September 1992. No evidence of leakage was observed from the tank during removal operations.

No contaminants were detected in the excavation beneath the tank above the 1 in 1,000,000 risk-based concentrations.

CFA-29, Waste Oil Tank at CFA-664. This is a former 1,000-gal waste oil tank installed in 1951 and last used in 1989. The tank and associated piping were excavated and removed from the ground in October 1990 after it failed a tightness test. Soil contamination observed in the excavation was removed and treated. No contaminants were detected in the excavation beneath the tank above the 1 in 1,000,000 risk-based concentrations.

CFA-30, Waste Oil Tank at CFA-665. This is a former 1,000-gal waste oil tank installed in 1960 and last used in 1989. The tank and associated piping were excavated and removed from the ground in September 1989 after it failed a tightness test. Soil contamination observed in the excavation was removed and treated. No contaminants were detected in the excavation beneath the tank above the 1 in 1,000,000 risk-based concentrations.

CFA-31, Waste Oil Tank at CFA-754. This is a former 15,000-gal tank used as bulk storage of waste oil. The date of installation is unknown; however, it was last used in 1985. The tank and associated piping were excavated and removed from the ground in May 1992. Contaminated soil observed in the excavation during removal operations was removed and treated. After removal of contaminated soil, no contaminants were detected in the excavation beneath the tank above the 1 in 1,000,000 risk-based concentrations.

CFA-32, Fuel Oil Tank at CFA-667 (North Side). This is a former 180-gal fuel oil tank last used in 1986. The date of installation of this tank is unknown. The tank and associated piping were excavated and removed from the ground in October 1990. No evidence of leakage from the tank or piping was observed during removal operations. No contaminants were detected in the excavation beneath the former tank or piping.

CFA-33, Fuel Tank at CFA-667 (South Side). This is a former 4,000-gal diesel fuel tank installed in 1951 and last used in 1986. The tank and associated piping were excavated and removed from the ground in October 1990. Soil contamination observed near the filling port of the tank was removed and treated. No evidence of leakage was observed from the tank or associated piping during removal operations. No contaminants were detected in the excavation beneath the tank above the 1 in 1,000,000 risk-based concentrations.

CFA-34, Diesel Tank at CFA-674 (South). This is a former 260-gal diesel fuel tank installed in the early 1950s and last used in 1976. The tank and associated piping were excavated and removed from the ground in October 1990. The tank contained several holes and leaked some of its contents into the surrounding soil. Soil contamination observed in the excavation was removed and treated. No contaminants were detected in the excavation beneath the tank above the 1 in 1,000,000 risk based concentrations.

CFA-35, Sulfuric Acid Tank at CFA-674 (West Side). This is a former 1,000-gal sulfuric acid storage tank installed in 1953 and last used in 1965. The tank and associated piping were excavated and removed from the ground in June and July 1989. No evidence of leakage was observed from the tank or associated piping during removal operations. No contaminants were detected in the excavation beneath the tank above the 1 in 1,000,000 risk-based concentrations.

CFA-36, Gasoline Tank at Building CFA-680. This is a former 55-gal gasoline tank installed in 1951 and last used in 1983. The tank and associated piping were excavated and removed from the ground in October 1990. No evidence of leakage was observed from the tank or associated piping during removal operations. No contaminants were detected in the excavation beneath the tank above the 1 in 1,000,000 risk-based concentrations.

CFA-37, Fuel Oil Tank at CFA-681 (South Side). This is a former 500-gal fuel oil tank installed in 1949 and last used in 1978. The tank and associated piping were excavated and removed from the ground in October 1990. Small holes and rust were observed in the tank during removal operations. Contaminated soil was removed from the excavation and treated. No contaminants were detected in the excavation beneath the tank above the 1 in 1,000,000 risk-based concentrations.

CFA-38, Fuel Oil Tank at CFA-663. This is a former 500-gal fuel oil tank installed in 1949 or 1950 and last used in 1980. The tank and associated piping were excavated and removed from the ground in May 1992. No evidence of leakage was observed from the tank or associated piping during removal operations. No contaminants were detected in the excavation beneath the tank above the 1 in 1,000,000 risk-based concentrations.

12. DOCUMENTATION OF SIGNIFICANT CHANGES

The proposed plan for the CFA landfills was released for public comment in April 1995. The proposed plan identified Alternative 3—uniform containment with native soil cover, institutional controls, and monitoring—as the preferred alternative. The agencies reviewed all written and verbal comments submitted during the public comment period. Upon review of these comments and preparation of the ROD, it was determined that no significant changes to the remedy would be required.